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Heating and Ventilating

JANUARY, 1932

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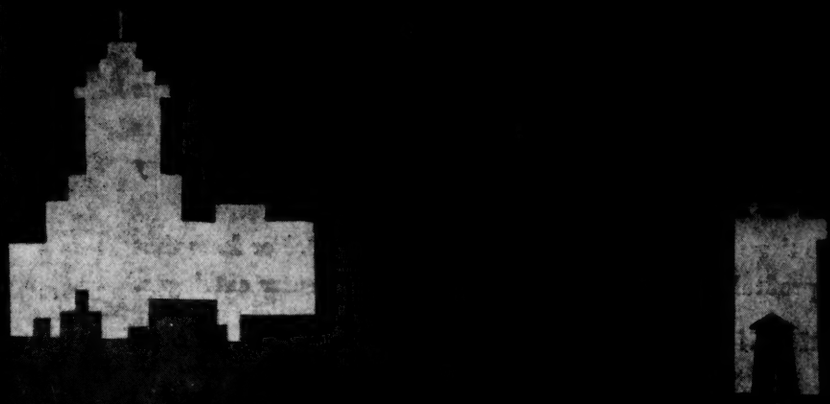


THE NEW YEAR

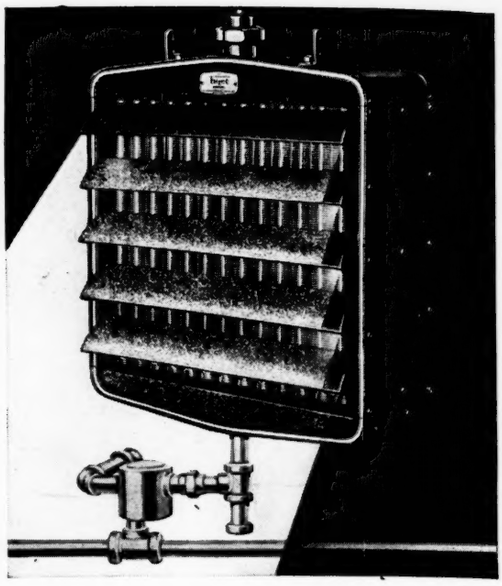
marks an era in the development of Cooling, Ventilating and Air Conditioning. The progress of the last ten years in this field is amazingly exemplified in the specifications for buildings already completed and now under construction. Comfort, convenience, efficiency, sanitation are served by this branch of engineering which is still in the beginning of its usefulness.

NOT MERELY HEAT—BUT

HEATING RESULTS

that's what you get from

the HIJET HEATER



There's a mighty big difference between heat and heating results. Unless a heating device properly distributes and diffuses the heat, owners can obtain little real satisfaction or economy from their heating system.

Heating engineers and contractors are turning to the Herman Nelson hiJet Heater because it delivers *superior heating results*, and because of its economical operation.

The sturdy hiJet Heater, by a high velocity jet discharge, projects warm air downward with sufficient force to dispel the cold air strata at the floor line. Its special features of design assure long range delivery and exceptionally good diffusion of warm air.

There are three hiJet Heater sizes—all easy to install. For facts that will prove profitable to you—write for latest hiJet Heater catalogue.

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Three reasons why the hiJet delivers exceptional heating results

1 **Streamline air flow**
In the radiator of the hiJet Heater modern engineering has produced a streamline air flow, free from baffles. Thus the hiJet delivers far more air per B.T.U.

2 **High outlet velocity**
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Since it delivers more air per B.T.U., the hiJet Heater's outlet temperature is comparatively low. Naturally, this results in far better diffusion than could otherwise be obtained, since excessively hot air and cold air do not readily mix. Good diffusion is a vital advantage of the Herman Nelson hiJet Heater.

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THE HERMAN NELSON hiJet HEATER

For the effective and economical distribution of heat in factories, machine shops, warehouses, mills, garages, creameries, bakeries, and other industrial and commercial buildings.

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Heating and Ventilating

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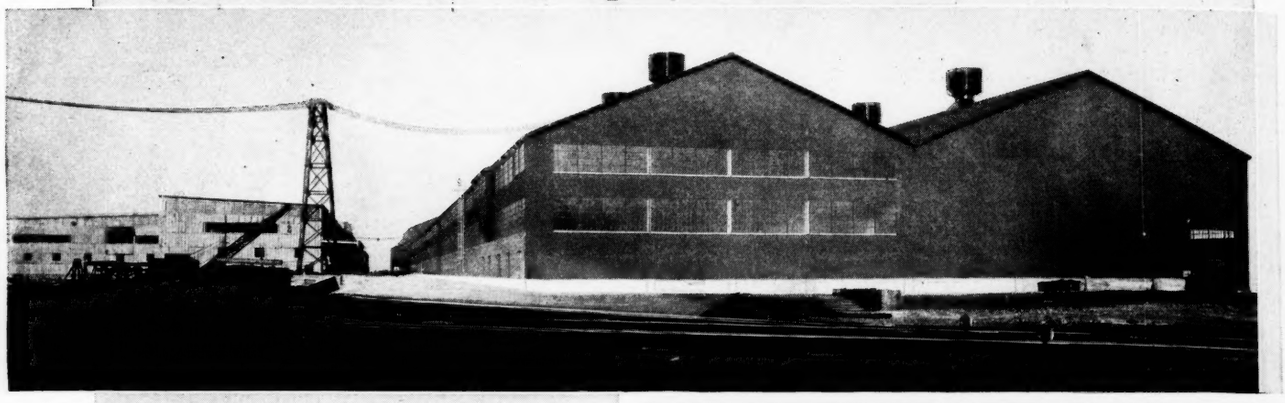
DESPITE THE TIMES . . .
Inland forges ahead with Great Strip-Sheet Plant

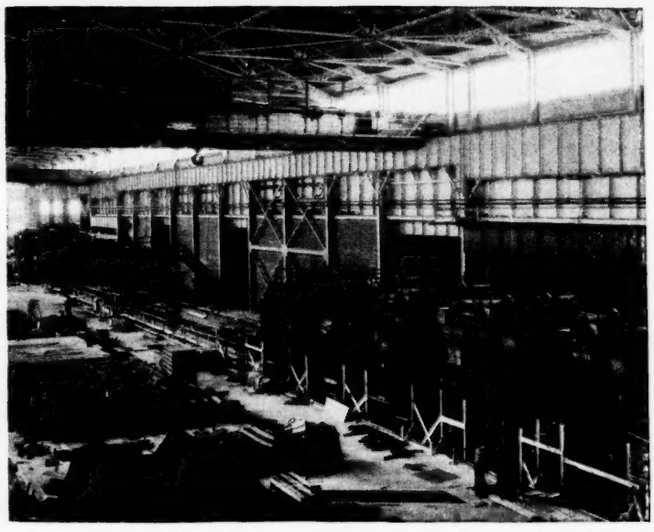


In the face of the steadily declining curve of business volume and earnings, the curve indicating Inland's range of products, Inland facilities and Inland service, has constantly risen during the past year.

To gain these ends—to prepare for the inevitable prosperity of American industry—to keep abreast of the finest and latest engineering achievements—Inland is just completing a huge new plant.

Early in 1932 this plant will start producing sheets up to the finest finishes, universal mill plates up to 60" wide, and hot and cold rolled strip. Included among the many new Inland products will be automobile body sheets, furniture sheets, fender stock, full pickled full cold rolled sheets, and numerous other high finished products.

The new Inland plant is the most advanced development of the continuous sheet mill idea. Its products will attain a new and greater standard of quality. Inland confidently welcomes the opportunity of placing them at your service. INLAND STEEL COMPANY, 38 S. Dearborn Street, Chicago, Illinois.



Above: Exterior of the group of buildings which will house the new Inland continuous plate, sheet, and strip plant.

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Below: Interior view of one building during installation of hot-mill stands.

INLAND STEEL

ABLE SERVANT OF THE CENTRAL WEST

Sheets Bars Plates
Structurals Piling

Rails Track Accessories
Bands Rivets Billets

EDITORIALS

Home Building

THE President's conference is now ended, and enough time has elapsed to permit a discussion of some of the points considered. The conference went about its work with thoroughness. The reports showed the time, effort and thought given to their preparation. Their assembly will provide information on home building and ownership never before available.

One of the most important items considered by the conference had to do with methods of financing. The device of home loan banks will surely be presented to Congress in some form. In the few weeks which have elapsed since the proposal was first made, it has gained substantial support. Those who have not lent support seem to be withholding it more because of disagreement over details than because of principles. Watch for the introduction of the proposal and be prepared to lend support, when and if needed.

One other result is evident even now. The attention given in the press has brought the subject of home building and home owning forcefully to the attention of millions of people. This, in itself, is worth while for it stimulates interest and thought—both necessary as the beginning of the building process.

•

Operating Data

ANYONE at all familiar with the published information available in the general field of heating, ventilating and air conditioning cannot fail to note that operating data collected from existing installations are almost totally missing. Here and there isolated bits of information can be found as someone has occasionally taken the trouble to collect and report it.

It is interesting to inquire why this is true. For one thing, the plants have but seldom been operated by people who are interested in collecting such material for the use of anyone but themselves. When collected there seemed to be but little incentive for making it public. For another, plants have seldom been equipped with sufficient measuring instruments to permit obtaining full data. Building owners and managers have been the men most directly interested and they have been responsible for most of the information which has appeared.

Why is it that those primarily concerned with the design and installation of these plants have considered that their interests do not extend to operation? Is there no relation between the design and installation on one hand, and the operation on the other? Can the designer learn anything from the operating man, or must the flow of information always be in the other direction?

These are questions for which no satisfying explanation has been offered, and yet which will not down.

Some recently installed plants have been well equipped with measuring apparatus. Perhaps information as to their operating characteristics will soon be forthcoming.

We cannot help feeling that if a way can be found to stimulate the collection of such data, and then to make it available in a manner which will be understandable but comprehensive and fair, many obscure points could be cleared up. More than that, it is quite possible that some notions to which we have all held so tenaciously might not be able to stand close study. Operating data, properly collected, can be made very useful in promoting progress and in revealing misconceptions.

•

Free Engineering

FREE engineering has again been under discussion of late. It is a subject which can be, and is, discussed without end and, evidently, without satisfactory solution. No matter how much one may either deplore or defend it, it is a condition which actually exists and which has every appearance of continuing for some time to come.

In all the discussion and talk pro and con, one fact stands out clearly, viz., neither its enemies nor its defenders can now muster enough strength to force their opponents to change existing practices materially. No more does either force or coercion seem to offer the slightest likelihood of producing a permanent solution. Attempts to bring about solutions by means of cooperative efforts hold promise, but there is no record of their having been successful, or indeed of their having been wholeheartedly tried.

The practice is deep-rooted and the problem is two-sided. A quick and easy solution is beyond reasonable expectations.

•

Famous Last Words

EIGHTEEN years have passed since the original New York State Commission on Ventilation was organized to undertake a study of school ventilation. Probably few realized at the time that the life of the

commission would be so extended. Recently, the final report has appeared. Presumably the commission has now finished its labors and will be dissolved. The recent report does not indicate whether or not the commission itself feels that its study is now complete. Perhaps it is final only in the sense that the commission proposes to pursue it no further.

It is too early to attempt to pass any final judgment on the ultimate value of the commission's efforts. It may easily be another eighteen years before it is possible to do so. That the commission during the period of its existence did accomplish some good, few will deny. How lasting its contributions will be only time will tell.

It is not too early to give thoughtful attention to the latest report, and to note how these later findings and conclusions differ from those of the earlier report of 1923 which caused such consternation and indignation among engineers when it appeared.

The most outstanding point is that, on the basis of its late studies, the commission has modified its stand that window-gravity methods are preferable to all others. Be it said to the credit of the commission members, that they have had the courage to admit that their early conclusions have proved incorrect. One can gather from the report, however, that the stand is abandoned with reluctance. Through the report there runs a current which leads to the thought that the members still feel that window-gravity methods have much to commend them and that they hate to credit their own data.

The report is characterized by a more tolerant attitude than was the 1923 effort. It discusses some subjects from the point of view of present knowledge, and admits that there are debatable points and gaps in the information, whereas the 1923 report made positive statements which would lead to the conclusion that the commission's information was absolute.

The commission has seen fit to incorporate its recommendations as to appropriate legislation into its report. Most of us will not agree with these recommendations in full; nevertheless, even here some appreciation of the viewpoint of the engineer is shown and the proposal contains concrete figures.

On the whole, the reaction produced by the most recent report is a tired feeling, together with a hope that the project may be left to rest in peace.

●

Coal Research

THE recent bituminous coal conference serves to call attention again to the plight of that industry. Coal has been replaced steadily as a heating fuel by oil and gas. Evidently, if volume is to be secured it must be by reversing this process, or at least by checking it.

In residential buildings this looks like a Herculean task—but with some hope in sight in the form of a slowly developing realization by those interested in coal, that they must accept innovations in methods and equipment. In many ways it is astonishing how slowly the facts in the situation are being accepted. In commercial buildings, coal's chief hope consists of showing superior economy over its competitors. Its ability to do so is largely a matter of locality.

Among the possibilities discussed at the conference was that of research. It cannot be said that research has been lacking in bituminous coal. The efforts, however, have been piecemeal and spotty without central direction. Extraction and preparation methods have received relatively more attention than have distribution and utilization. We cannot help feeling that if raw bituminous coal is to regain and hold the building heating business, intelligent, thorough and centrally-directed study will play an important part, and that it must be concentrated on distribution and utilization methods.

●

Domestic Air Conditioning

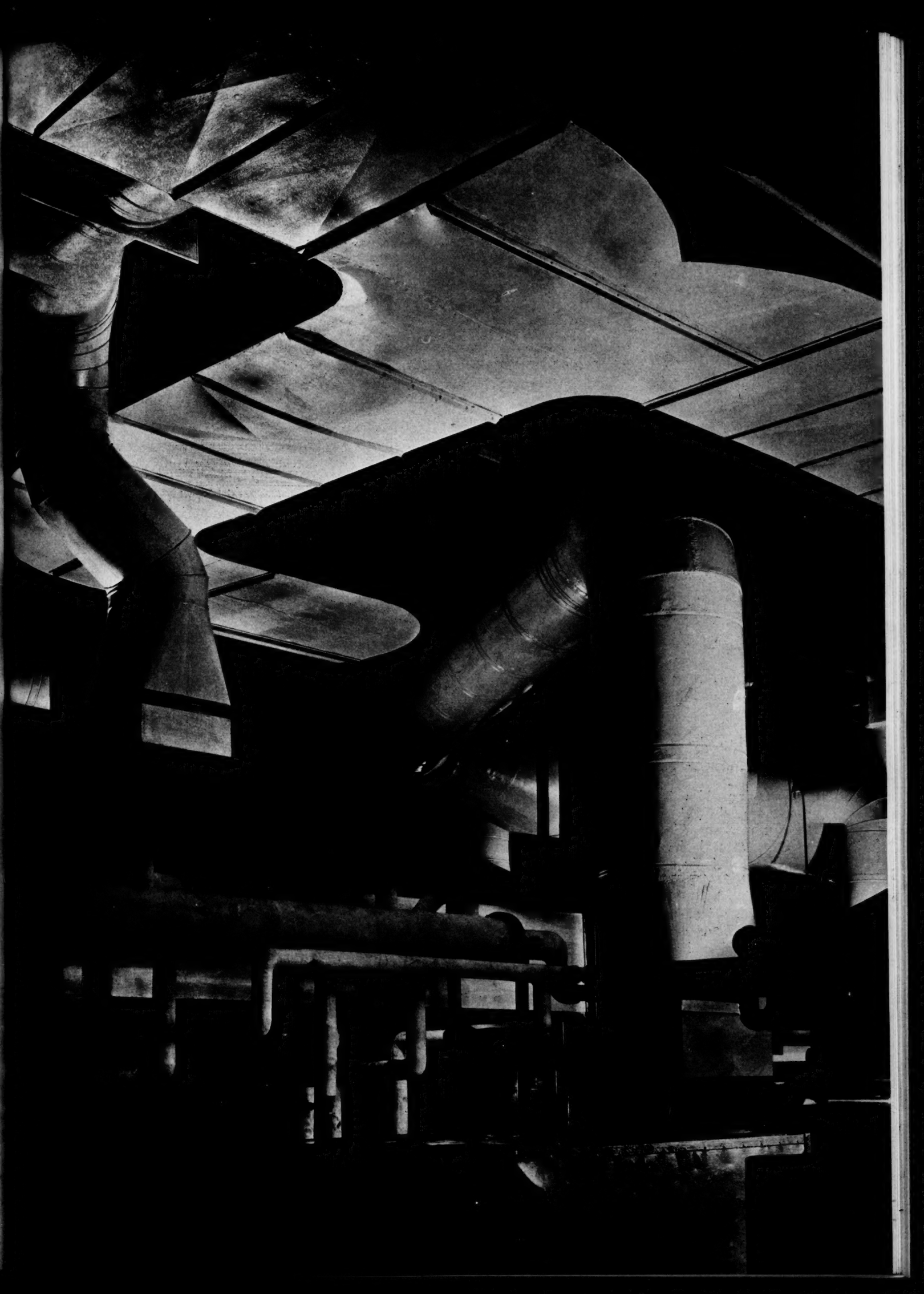
AS THE months pass, it is becoming more and more evident that house-heating plants are to have some air conditioning features incorporated into them. The past year has seen a decided increase in public interest in the subject. This has been greatly helped by the publicity which has been directed toward making its features better comprehended by the public. The virtues of a warm-air plant in this connection have been stressed. Arranging for holding the meeting of the National Warm Air Heating Association in Washington at the time of the President's Conference last month, was a master stroke. It brought attention to a meeting of an active trade association as probably nothing else could have done. Behind the leadership of this association, things seem to be picking up for warm-air heating in this its most logical field of application.

It does not seem possible that this popular trend toward centrally distributed air for house-heating is to be allowed to pass unnoticed by those primarily interested in the use of steam and water. Just what their reply will be is not yet apparent. We wonder what—and when.

●

Optimism in Reverse

THIS season has usually been the one for prophecies for the coming year, especially concerning business conditions. These seem fewer this year than during the boom period of recent memory. Just why there should be such a falling off in these prophecies is hard to explain. While prophets are scarce, there does seem to be an unmistakable feeling that the worst is over. After all, the presence of such a feeling is probably to be preferred to a broadside of popular and optimistic prophecies.



Coal and Coal-Burning Equipment for Medium-Sized Heating Plants

By I. R. HOFFMAN†

A discussion and description of the coals available in the east, and means for burning them in medium to large-sized furnaces. Small residential heaters are mentioned only incidentally.

COAL of nearly any desired characteristic can be readily obtained in the east. Heating furnaces until but recently largely were hand-fired, while large ones were stoker-fired. Recently, stokers for firing small furnaces have been developed to such a point that they are rapidly gaining favor, especially in apartment houses and buildings of similar size and character.

Selection of a suitable stoker is, therefore, not limited by the coals available to anything like the extent that this is true in other parts of the country. The problem, instead, is to select a stoker which can be expected to handle the load in the particular furnace with a coal which can be obtained at a suitable price. Often it is desirable to select a stoker which is capable of handling as wide a variety of coals as practicable.

It can be said that no one stoker can reasonably be expected to handle all grades and kinds of coal equally well. In order to make present practices clear, the characteristics of the principal coals are described, followed by a description of the stoker types in which they are burned to advantage.

Eastern Bituminous

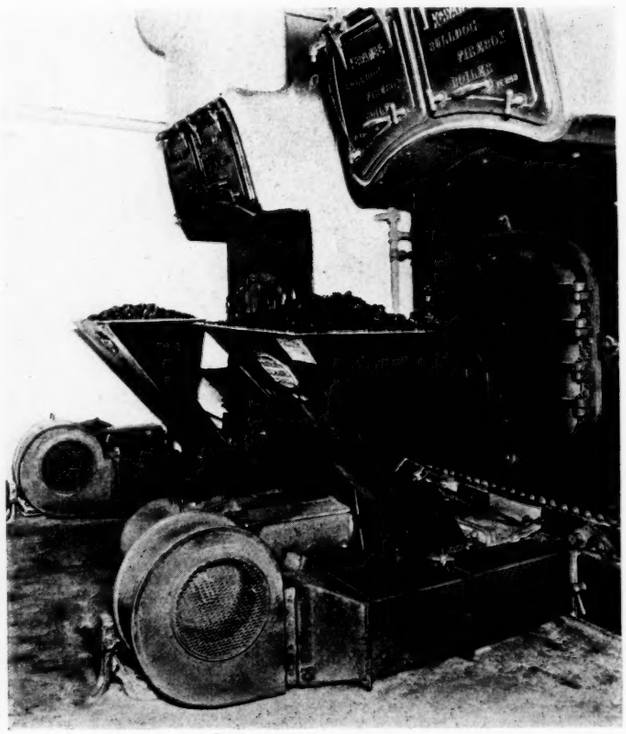
Eastern bituminous coals are divided into three groups, according to volatile content: high volatile, 32% to 41%; medium volatile, 21% to 31%; low volatile, below 21%.

The high volatile coals (Western Pennsylvania, Eastern Ohio, Eastern Kentucky and parts of West Virginia) have 30% to 38% volatile, 50% to 60% fixed carbon, 5% to 12% ash, 3% to 10% moisture and 13,000 to 14,000 B.t.u. per lb. dry. They are difficult to burn smokelessly due to large amounts of heavy hydrocarbons consisting of tarry gases which require much combustion space. The caking tendencies of these coals give no trouble and the coke does not swell under high temperatures.

Medium volatile coals (Southeastern Jefferson, Central and Western Westmoreland, Eastern Fayette and Indiana Counties in Pennsylvania are closely related to the low volatile coals.

The low volatile (or semi-bituminous) coals (Pocahontas and New River fields in Southern West Virginia, the Georges Creek field in Northwestern Maryland and the Central Pennsylvania field of Center, Clearfield, Cambria and Somerset Counties; also Blossburg, in Tioga County, and the Broadtop field in Bedford and Huntingdon Counties) contain 16% to 22% volatile, 68% to 77% fixed carbon, 3% to 10% ash, 2% to 6% moisture and 14,000 to 15,000 B.t.u. per lb. dry. A marked tendency of these coals is to swell and coke into a solid mass when subjected to high temperatures, which gives them the name of "coking" coal. The coke stands up in the fire in large lumps, forming large fissures, and does not break down unless properly agitated. This coking tendency varies according to seams and mines. It is very necessary to agitate the coal, especially during the early stages of combustion. The volatiles are light hydrocarbons, easily burned, and as the fixed carbon is high, this coal is comparatively slow burning and more easily controlled than high volatile coal.

The fusing temperature of the ash in the low volatile coals is uniformly high —about 2500° to 2800° —permitting comparatively high combustion rates without serious clinker trouble. As fuel bed temperatures vary from 2200° to 3000°, it is obvious that ash permitted to remain in this zone will cause clinker troubles, even with



A stoker installation in a bank building.

† Fuel Engineer, Central Coal Co., New York, N. Y.

the best coals. Excessive combustion rates generate higher fuel bed temperatures with resulting difficulties.

Most of the low volatile coals are easily friable and develop much slack through handling. It is, therefore, difficult to ship sized semi-bituminous.

The stoker coals are usually nut and slack of a size designed to pass through the stoker feed openings. To avoid dust in handling, stoker coal is often washed to carry off the fines. Nut coal passes through a bar screen with openings of ¾ in. to 1½ in., and passes over ½ in., giving us 1½ in. nut, 1 in. nut, etc. Stoker coal is usually a combination of nut and slack, but is often called ¾ in. slack, ½ in. slack, etc., according to the screen opening through which all the coal was passed.

Pennsylvania Anthracite

This coal occurs in four distinct fields in Eastern Pennsylvania and is known commercially by names derived from the field of its source or from the burning and ash characteristics. Many of these names have come to be well known. Among them are the following:

Hard white ash coal.—Ignites with difficulty but is high in heat value and is a good steam coal.

Free-burning white ash coal.—Is usually low-fusing, clinkers badly, and must be intelligently handled to avoid clinker trouble.

Schuylkill red ash coal.—Is free-burning, i.e., requires little draft, and is good for domestic purposes.

Shamokin coal.—Is also a good domestic fuel.

Lorberry red ash coal.—Contains very little volatile.

Lykens Valley red ash coal.—Burns with a long flame, is free-burning and makes a good steam coal.

Wyoming red ash coal.—Is very similar to hard white ash, except that it contains much iron.

Trevorton coal.—Is low in heat value and somewhat friable.

The fusing temperature of most anthracite ash is over 2600°, but those coals having lower fusing points clinker easily.

All anthracite coal is screened and sized. The various steam coal sizes and trade names are as follows:

	Round Hole Screens	
No.	Through	Over
Pea		
1 Buckwheat	5/8"	3/8"
2 Buckwheat (Rice)	3/8"	3/16"
3 Buckwheat (Barley)	3/16"	3/32"
Culm	3/32"	.....

The percentage of undersize should not exceed 15% to 18%. The fusing temperatures should be not less than 2600°, but coal can be readily obtained in which it is from 2800° to 3000°. The quality of steam sizes of anthracite, measured by modern practice, varies as follows:

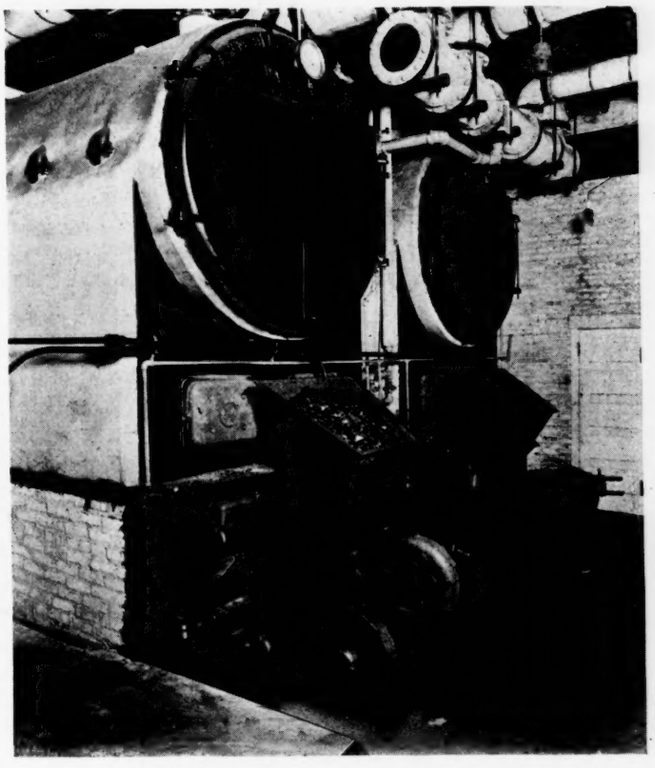
	Ash	B.t.u. (Dry)
Excellent coal	Less than 13%	Over 12,800
Good	13% or 14%	12,500 to 12,800
Fair	15% or 16%	12,000 to 12,400
Poor	Over 16%	Under 12,000

A good anthracite fire must be maintained level to provide uniform resistance to the air. Very often an uneven fuel bed will offer uniform resistance due to varying thicknesses of the bed of ash, but only the expert fireman can handle such a fuel bed.

The ash content of steam sizes has recently been reduced through improved methods of cleaning the coal. One flotation method uses a mixture of sand and water in a huge cone-shaped shell. The specific gravity of the sand and water mixture is such as to permit the slate and stone to sink while the clean coal is drawn off at the upper level. The time element, or interval during which the cone holds a given charge of coal, also affects the efficiency of the cleaning operation.

For best results with hand-firing a low-ash, medium free-burning, non-clinkering coal should be used, although it must be realized that any coal will clinker under excessive combustion rates. The coal should be fired light and often. All of the ash must be removed from the fire during cleaning periods to insure a proper fuel bed. The first half hour after the cleaning of a fire determines whether the fuel bed is being properly built up or not.

For hand-firing steam anthracite, a combustion rate of about 13 lb. to 20 lb. will give best results for continuous operation at boiler capacity in water tube and H.R.T. boilers; and 8 lb. to 13 lb., in steel fire-box boilers. Combustion rates in small heating boilers range from 4 lb. to 8 lb. per sq. ft. per hr. Grate areas should be designed or checked with these factors as a basis.

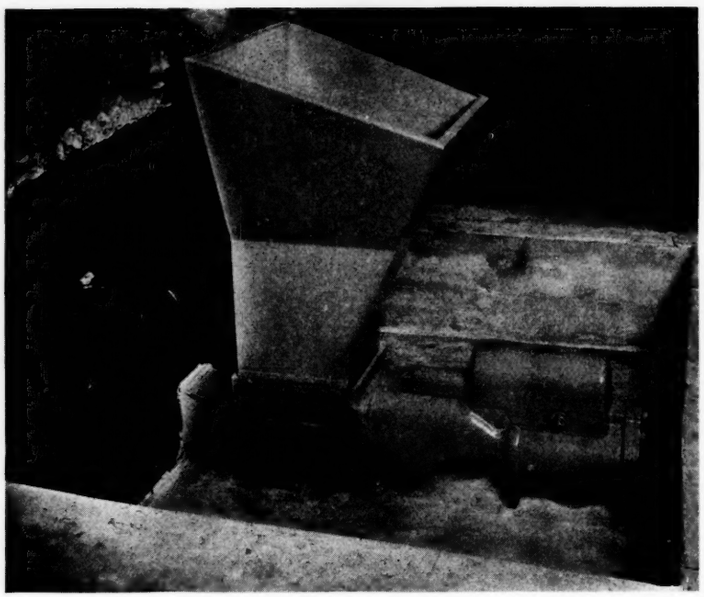


A stoker-fired heating installation in an apartment house.

Combustion

The ideal method of combustion is to subject each particle of coal to high temperature and surround it with just sufficient air to insure complete combustion. This method is approached by the pulverized coal system, which has been developed for successful use in larger furnaces only.

A definite amount of air is required for burning a given amount of coal. Insufficient air permits carbon monoxide to escape unburned; excess air absorbs heat from the fire



A small office building installation.

and carries it away. About 30% excess air is the nearest practical approach to perfect combustion requirements, but 40% to 60% excess air is nearer the usual method of good operation.

One of the most important requirements for proper combustion is a fuel bed offering uniform resistance to the air. There must be no holes or thin spots in the fire through which air will flow in uneven rates. Fuel bed thicknesses on underfeed stokers will range from 12 in. to 24 in.; on overfeed, or natural draft, stokers, from 6 in. to 12 in.

Combustion Processes

Combustion of coal takes place in two stages: Combustion in the fuel bed (simultaneous with the distillation of volatile and the gasification of fixed carbon) and combustion of the volatile and other combustibles rising from the fuel bed.

As the gases distilled represent from 40% to 60% of the heat units in the coal, it may be said on an average, that half the process of combustion takes place in the fuel bed and the other half in the space above the fuel bed.

In the absence of sufficient oxygen for their complete combustion, the hydrocarbons, constituting the volatile matter, are quickly decomposed by the high furnace temperature into soot, hydrogen and carbon monoxide. The reaction between the products of decomposition and carbon dioxide produces carbon monoxide, which, therefore, persists in the furnace gases after all trace of other gases has disappeared.

In burning any fuel, the balanced draft principle of operation can be made to yield good results. The suction, or draft, over the fire should be balanced to an intensity where it is just sufficient to carry off the furnace gases without being required to overcome the fuel bed resistance. About .05 in. W.G. is necessary. All the air for combustion should be furnished by the blowers.

This method permits the stack damper to be closed down, reduces the velocity of the gases through the boiler, and thereby increases the heat transfer to the boiler. Careful operation with natural draft may accomplish practically the same results.

Smoke

Soot (smoke) is formed at the surface of the fuel bed by heating the hydrocarbons in the absence of air; it is also formed by the hydrocarbons striking the cooler surfaces of the boiler. When they strike the cooler surfaces they become and remain stable. Blue flame indicates burning of carbon monoxide. Luminous flame is composed of incandescent particles of carbon. If these particles strike the surfaces of the boiler, they are cooled below the temperature of combustion and pass off as particles of carbon or soot. Boiler surfaces collect soot already formed; prevent its combustion, and thus acquire a coating of insulation which prevents the transfer of heat from furnace gases to boiler.

Bituminous Stokers

The two types of stokers for burning bituminous coal in medium and small boilers are the underfeed and overfeed. In underfeed stokers the coal enters the furnace from below the fuel bed at desired rates of feed, is heated gradually, and the volatiles slowly distilled. Overfeed stokers introduce the coal in regulated quantities over the fire, usually at the front of the furnace. They agitate and move the fuel toward the rear by a series of moving grate bars and place the ash on a rear dump plate which is periodically operated by hand.

The underfeed type is particularly adapted for burning coking coal. The tendency of this coal to coke and swell, and the pushing action of the coal feed, keeps the fuel bed porous and broken up. If the stoker is equipped with agitated grates, it is a further marked advantage. A deep fuel bed is required for proper resistance to the high air pressures necessary for coking coal. The low ash content of the low volatile coals makes cleaning infrequent and quickly accomplished.

Underfeed stokers are often equipped with side dump plates which receive the ash at the sides of the furnace and permit its periodical disposal into the ash pit. Stokers having no side dumps make it necessary to remove the ash and clinker through the fire door, which is thereby kept open for long intervals, cooling the furnace and boiler. A serious feature of this operation is the mixing of ash and unburned coal, which is removed as ash. Small domestic stokers make advantageous use of this method of removing ash.

The feeding mechanism of underfeed stokers has an important bearing on the proper burning of the coal. Slow and continuous feeding by the operation of a screw may tend to pack the fuel and, as the upward motion of the fuel is slow, the coke mass is slowly broken up. This type is much used for small furnaces, such as found in heating boilers.

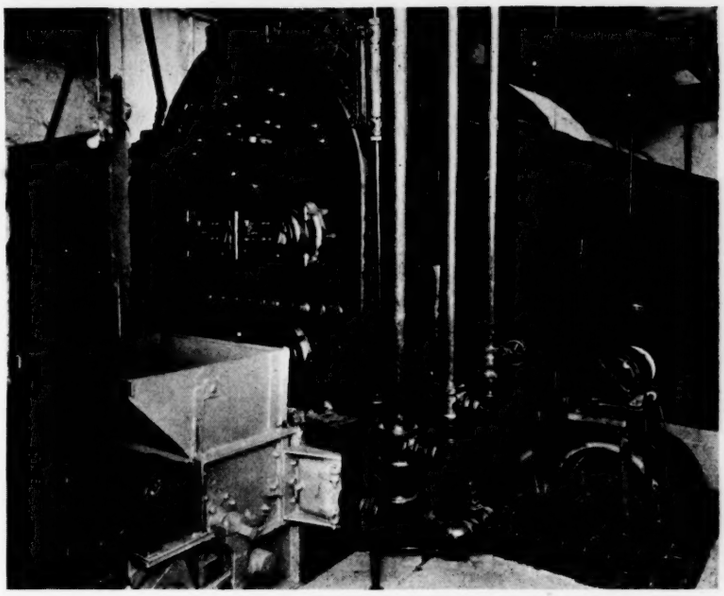
The plunger feed operating intermittently, forces a more positive upheaval of the complete fuel bed with

each stroke, breaking down the lumps of coke.

Agitated grates are imperative for furnaces exceeding about 7 ft. in width to insure even distribution of the fuel to the side of the furnace without excessive piling of fuel in the middle.

The spreading action alone resulting from agitated grates in furnaces less than 5 ft. or 6 ft. wide is negligible, as the fuel is evenly distributed by the action of the coal in the retort. Consequently, stokers intended for small furnaces use stationary grates. A weakness of several of the underfeed stokers using screw feed is the high maintenance of the feeding screws. Most of the stokers of the kind just described are intended for use in furnaces whose grate areas do not exceed 20 to 25 sq. ft., or in boilers of over 125 hp.

In process and heating plants, such as are often found in laundries and similar industrial buildings, overfeed natural draft stokers are often used where continuity of operation is paramount. Many such plants consist of but one boiler, and it can be hand-fired without running the stoker, in case of electric power failure or breakage of the stoker mechanism.



A stoker-fired plant in a small industrial building.

Attempts to adapt chain grate stokers for small boilers are now being made and have met with considerable success. These stokers are also being adapted for use with small anthracite.

Where low and medium volatile bituminous is burned, the distance from the fuel bed to the underside of the boiler shall be 3 ft. to 5 ft.; and for higher volatile coals, this distance should be increased to about 7 ft. Approximately 4 to 8 cu. ft. of furnace space are required for each square foot of grate area, with combustion rates up to 35 lb. per sq. ft. per hr.

Perhaps the most interesting development as regards future possibilities in the burning of bituminous coals, is the small stoker system which feeds the coal, removes the ash, and maintains the desired temperature in residences, stores, apartments, and other small buildings up to 3,000 sq. ft. of radiation.

Anthracite Stokers

Chain grates are the only mechanical stokers which advantageously handle steam sizes of anthracite such as rice, barley and culm. A chain grate stoker is comparable with a moving platform on which the coal lies undisturbed, moving through varying temperature zones at uniform rates of speed, until burned.

Attempts have been made to burn anthracite on underfeed stokers. The result has invariably been to form a large clinker, to mix the fuel and ash, and to break parts of the stoker-operating mechanism.

For hand-firing, stationary and dumping grates are used, with slotted openings preferred for better air distribution. With stationary grates, the ash must be removed by winging the fires and pulling the refuse through the fire doors.

Dumping grates permit the fire to be pushed back while the ash in front is dumped, after which the fire is pulled forward and the ash in the rear is dumped. Then the fire is leveled. The advantage of the dumping grate is that it makes possible rapid cleaning of the fire, eliminates much of the dust caused by pulling the ash through the fire doors, and cuts down the labor of cleaning fires.

Dumping grates are used primarily for hand firing buckwheat, rice, barley and culm. For pea coal and larger sizes, the shaking grate is used.

A recent development is the small stoker for residences and other types of small buildings. This stoker automatically feeds the coal and removes the ash, besides operating in conjunction with a temperature regulation system which assures a proper degree of heat as required.

The fuel burned is buckwheat or rice and is usually fed on the underfeed principle, although various forms of overfeed are available. As the combustion rates are necessarily low, the danger from clinkering is eliminated. Several such stokers have been placed on the market with marked success.

Finally, in selecting any type of equipment for burning coal, it is equally important to consider the maker and the size of his organization with the type of service rendered after the equipment is placed in operation. The excellence of equipment alone, without the assurance of proper service, is emphatically not sufficient justification for purchasing or recommending that equipment.

Fire Protection Association Report on Gas Heating

A PART of the city gas division of the report of the committee on gases of the National Fire Protection Association is printed below. The report was presented at the thirty-fifth annual meeting of the association at Toronto some months ago.

The report of the city gas division was submitted to the sixteen members of the committee, fifteen of whom voted affirmatively, and one did not vote. The part of the report reprinted here is concerned with gas-fired boilers and gas conversion burners.

General

(1) These regulations are intended for application only to low pressure heating systems. Such systems shall be defined as those wherein the pressure does not exceed 15 lb.

(2) No gas-fired boilers or furnaces for heating a building or buildings shall be installed and no boiler or furnace designed for other fuels shall be converted to the use of gas fuel unless the following regulations are complied with.

(3) Either a thermostatic pilot light, so constructed and adjusted that no gas can flow through the main burner unless the pilot light is burning, or some other similar type of safety device serving this same end shall be employed. The operation of the safety device shall not depend on the closing of an electric circuit to shut off the main gas supply.

(4) The boiler or furnace shall be equipped with safety devices arranged to shut off the main burners in case of high steam pressure or low water (or high temperature) for steam or vacuum vapor boilers, or high air temperatures for warm-air furnaces. A steam or vaccum vapor boiler quipped with a high temperature limiting device need not be equipped with high pressure or low water cut off. These devices shall not depend upon the closing of an electric circuit to shut off the main gas supply. This section shall not be understood to prohibit the use of electrical regulating devices provided safety devices meeting the above requirements are also installed.

(5) An approved gas pressure regulator of sufficient size shall be installed in the gas line leading to the appliance.

(6) All boilers or furnaces shall be connected to flues. The size of the flue and flue pipe shall be proportionate to the maximum rate of gas consumption, not less than 10 sq. in. in cross-sectional area for each 50,000 B.t.u. of gas used per hour. All flue pipes shall be provided with a draft hood or down-draft diverter of an approved type which shall have a cross-sectional area at least equal to that of the flue pipe. No damper shall be installed in the flue pipe unless so arranged that the main gas valve will not open until the damper has opened and the damper will not close until the main gas valve has closed, in which case the damper and draft hood shall be so located and proportioned that they will not cause the formation of carbon monoxide even if the damper is closed while the gas is burning. Where dampers are an integral part of the heating plant, they shall be removed or permanently secured in the wide open position.

Flueways and Chimneys

(1) Flueway and chimney construction shall conform to that recommended by the Building Code of the National Board of Fire Underwriters. Such flues and chimneys shall not be used to vent the products of combustion of any other appliance utilizing fuel other than gas.

(2) Care shall be exercised to prevent the flue pipe from entering the chimney so far as to unduly restrict the space between its end and the opposite wall of the chimney.

Draft Hoods or Regulator

The draft hood or regulator shall be of a type that will insure the ready escape of the products of combustion by maintaining a draft sufficient for the burner for which it is designed, and prevent a back draft from interfering with the proper operation of the burner.

Installation

(1) Previous to the installation of a conversion burner, the ash pit door of the heating plant shall be permanently removed, or bottom ventilation otherwise provided to prevent the accumulation of gas within the ash pit unless the burner is of a type which mechanically purges the ash pit.

(2) When the ash pit door is closed it is recommended that the other doors of the heating appliance be hinged at the top to swing freely or to be otherwise arranged to relieve pressure due to puffs or backfire caused by delayed ignition.

(3) All heating surfaces and flue ways of the plant shall be gas tight and shall be thoroughly cleaned of soot, carbon, and other foreign substances before the burner is installed. Where leaks are found in the walls of the combustion chamber heating surfaces, or flue ways, such defects shall be adequately repaired before the installation is completed.

Burners

(1) Conversion burners shall consist of factory assembled and tested units accompanied by complete and comprehensive installation and operation instructions that observe the foregoing and following features.

(2) The equipment shall incorporate acceptable provisions for adjustment, control, support and attachment to the heating plant or to the foundation on which it rests. It shall be so installed (and attached) as to prevent twisting, sliding, or dropping out of the intended correct position.

(3) Installation and assembly shall be such as to permit ready accessibility for inspection, repair, and replacement of parts.

(4) Each burner shall be installed with a properly designated manually operated shut-off valve in the main gas supply line to the burner. This valve shall be positioned at a point readily accessible for use and inspection.

(5) Burners should be supplied by an independent gas line direct from the meter.

Heating and Ventilating as Practised in Central Europe

By KONRAD MEIER†

DIRECT heating is generally planned in Europe with manufactured goods similar to those originally brought out and still used extensively in the United States of America. The casual observer will, therefore, merely note some differences in the details of installation, which for many plants are really the only distinguishing features. Nevertheless, a discussion of the European practice should be of interest to American engineers, because of certain deviating tendencies in the methods of application. These tendencies did not receive much attention for some time after the introduction of the sectional radiator, then were most pronounced and are now becoming apparent again with the recent developments in architecture and heating. A brief review will show the general situation in this respect.

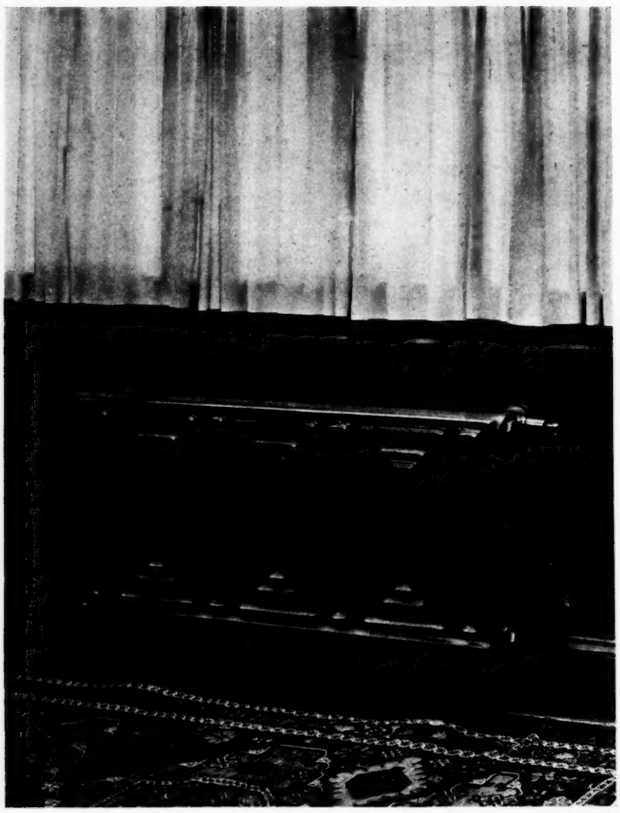
In central Europe one can still find numerous and notable examples of the massive old tile ovens which were built to store up the heat from a quick wood fire and to give it up slowly by radiation and convection through their generous spread of clean and moderately hot surface. Originating in the rigorous climates of the interior, they have survived for centuries, and owing to their desirable qualities quite similar stoves are still being built for wood fuel today. The Franklin stove was the equivalent for coal firing, also utilizing radiation and the air heat for better effect, since the open fireplace from the milder western European parts proved inadequate for the severe New England climate. But there the idea of convection was carried further, because convenient and inexpensive. It found exclusive application in furnace heating and the various indirect systems of steam and water heating, now succeeded by the invisible devices. In the colder European countries the early steam heaters were first built on the old plan of radiation with a more incidental use of convection in the form of bulky sheet iron cylinders. These were followed by cheap cast iron types with extended surfaces, which could not be used without concealment. They were readily abandoned after the appearance of the American sectional radiator. Although designed for exposed application, screening still had to be resorted to in many cases for architectural reasons and to cover up the imperfections of installation. With the improvement of the latter, this by-work is gradually being abandoned here. In America, on the contrary, the practice of enclosing seems to be on the increase and the trend is for air heating, while in Europe the leaning is towards radiation.

† Consulting Engineer, Winterthur, Switzerland.

These tendencies are, of course, not equally pronounced throughout the continent. Indeed, practice shows considerable variety, and there is a large field where the ever-increasing commercial intercourse has had a levelling effect. But it is interesting that methods should differ mainly for the more severe climatic conditions, where heating is well developed, and for about equally substantial building construction. Hence, the requirements must be about the same, and yet there is the undeniable fact that the American client calls for decidedly higher room temperatures, 70° F. being the standard, whereas in Europe the average is about 65° F. Evidently this is not due to personal habits alone, nor is it the result of economical considerations, since most people are satisfied with that temperature and many are comfortable even at 60° F. Nor can it be said that heavier clothing is worn. The fact is, that 18° C. (64.4° F.) is looked upon as a fair standard for living rooms. At an average of 50% relative humidity this falls just outside the zone of comfort established by the Research Laboratory of the A.S.H.V.E., which calls for comment.

If it is true that individuals will grow accustomed more or less to heat and cold, it must also be admitted that such thermal standards can never be absolute and should be considered in relation to the personal factor. But there are still other points not heretofore included in the research. Among these are the systems of heating, as affecting air conditions indoors. Dry bulb temperature, relative humidity and air motion cannot be an adequate expression of comfort wherever radiant heat is contributing to it or figures among the losses. Moreover, the method of measurement, which has been criticized of late, will make a difference in the numerous cases where the heat distribution is not uniform. Hence, it is by no means certain that the personal feeling is the main reason for a differing standard. Indeed, a closer study of the practice on both sides will show other causes.

With the various systems depending entirely on air circulation by gravity for distributing the heat within the room, it is not practicable, as a rule, to prevent overheating of the upper strata at the expense of the occupied zone. And as such warmer strata overhead always increase the tendency for leakage, which must be made up, this means increased change of air generally at higher temperature and lower relative humidity. In any case, where the walls and contents of a room must be warmed by the air alone, the latter will have to be at a higher temperature. Thus, for air heating and all the apparatus with concealed surfaces the dif-



Radiator with three grille and two end sections, wall supports and concealed connections

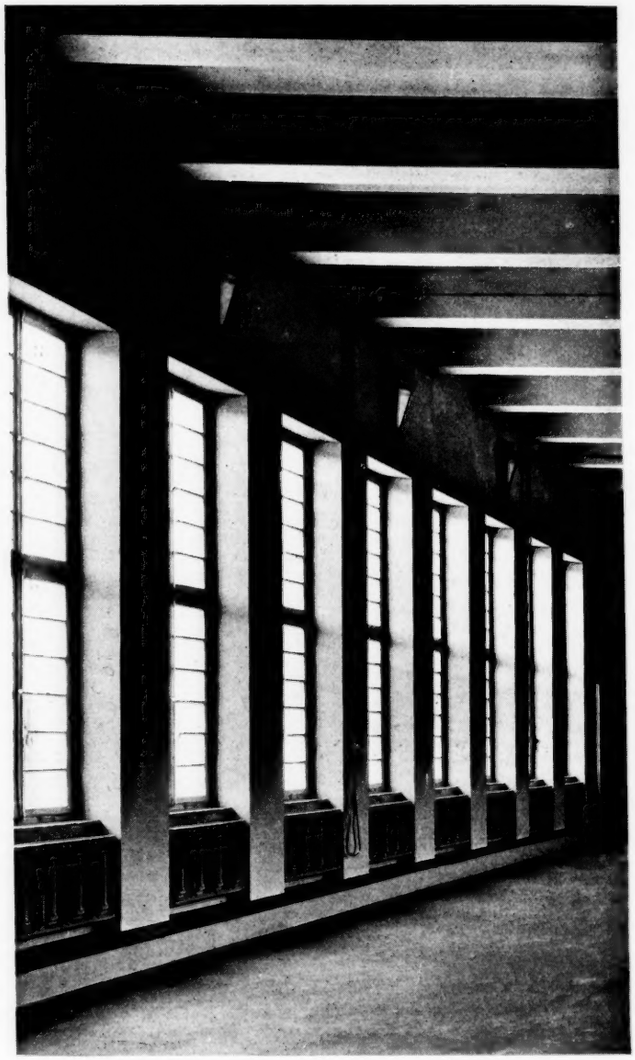
ference in the air temperature required seems readily accounted for.

In the case of direct heating, the reasons are less obvious and probably the requirements do not vary quite to the same extent. Also, in the countries with milder and more humid climate, slightly lower room temperatures are in order. But there must be further causes. The one outstanding difference in practice lies in the general use of water heating for domestic, public and business buildings. The experience gained with this system has naturally resulted in better installations, which may be said on the whole to be as responsive as steam heat but easier to control. Very fair results are obtained with central regulation and local hand valves. The surface temperatures practically range below the point where dust becomes irritating. And as the radiant heat is pleasant at that range, it can be utilized to advantage. There is no need of screening to prevent disagreeable effect. Even with the recent and improved steam heating, these qualities have not been attained and with the average existing installation there is probably more overheating with less radiation and correspondingly more convection. Hence, the prevailing impression of drier air with steam heat is borne out by the facts and the higher temperatures are at least partly explained by the system.

Recent studies have confirmed that the relative humidity in heated rooms is not directly dependent on temperature differences between inside and outside air, as theory would have it, but is largely influenced by internal sources of moisture. Among these is the building itself and its contents, which alternately absorb and give up water unless dried up gradually by continuous and intense heating. Naturally, the drying effect of heating apparatus is about in proportion to the amount of heat expended, whether needed for comfort or not. It will, therefore, be greater wherever losses due to faulty distribution must be made up by additional supply.

This explains why warm-air systems with an overheated zone create a drier condition in rooms, quite aside from the lower saturation due to higher temperature. And herein also lies the reason why the demand for air moistening is still active in the United States, while the leading hygienists in central Europe now fairly agree that artificial humidification is neither necessary nor desirable under ordinary conditions. As a matter of fact, the relative humidity almost never drops below 40% nor rises above 60% in moderately warmed living and working rooms of average occupancy. Complaint about dryness can generally be traced to dust when dried and set in motion by the heating surfaces. Thus, every loss of heat and every excess means not only waste, but also less comfort.

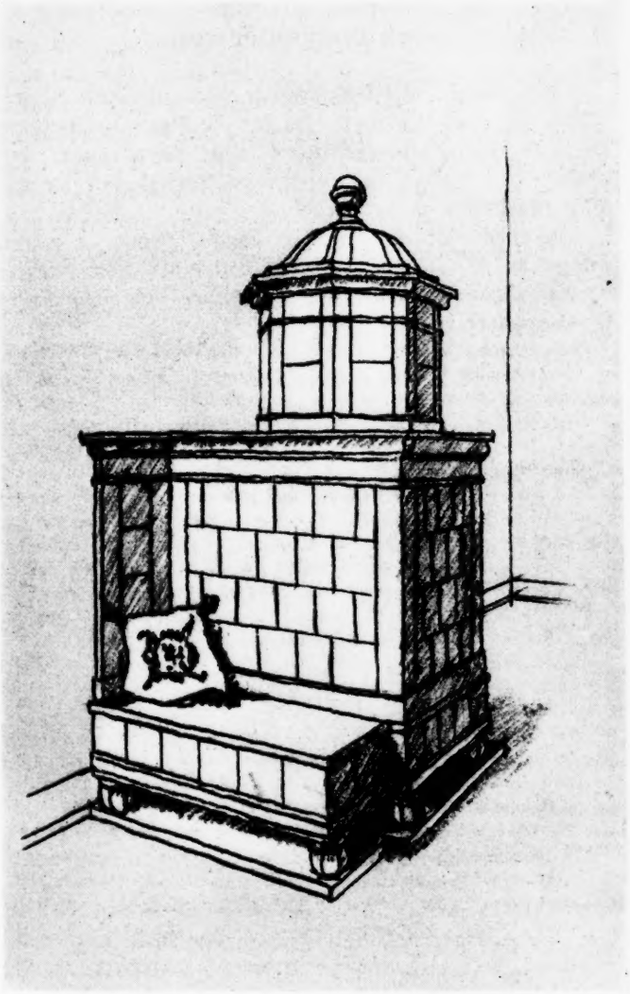
The aim should always be to approach the natural air condition. That the utilization of the radiant heat,



Heating surface in slabs with front for radiating and back side for air heating to meet down-draft and in-draft. Lengths can be varied by insertions

which increases comfort without raising the air temperature, will contribute to this result has been amply confirmed by the experiences at winter resorts and in certain hospitals where stress is laid on cool and dry air. Temperatures down to the freezing point are borne without discomfort, even in the scantiest clothing and with moderate air movement under the direct rays of the sun, which makes up for the lack of air heat. For the same reason, well placed radiation is most useful in supplementing convection. In fact, it would seem rational to figure and depend on radiant heat as far as practicable and resort to air heat only as needed to meet indraft and downdrafts or to even up distribution. In Europe some headway is being made in this direction, as shown by the types of heating surfaces in use. While in the United States the two-column radiation or its equivalent in the tubular is still a sort of standard applied wherever possible, the corresponding patterns in central Europe have been supplemented long since by radiation designed for use underneath windows and by flat arrangements.

Like the American wall sections, these window radiators are cast in slabs, but they give uniform combinations of any length, as needed for recesses. Owing to their general proportions the surface is fairly spread out as desired for good distribution. A neat and clean-cut appearance and the reasonable price have added to their popularity. When properly installed with run-outs concealed in walls and mounted on brackets leaving the flooring clear of piping and supports, these radiators are now often accepted without concealment, even in well finished rooms. This means that a fair portion of the heat is applied by radiation and generally in the proper place. The flat arrangement is also most effective in that way. Going a step further, radiation was designed specially for neatest installation, requiring neither recesses nor shelving as are often arranged merely to suppress the unsightly pipe ends and accessories. Having a distinct front for radiating effect, while the side facing the wall induces free circulation of moderately heated air to meet the chill from the windows, this style of surface also promotes the best room heating efficiency and comfort at lowest air temperature. However, the very broad windows coming into vogue with modern architecture are now calling for still greater spread of surface. To meet this situation, neatly welded pipe coils have been used of late, not only for lofts but also for living rooms and classrooms pending the production of a sufficiently flat, adaptable and well-finished radiator.



Tile stove, Eighteenth Century style, formerly fired from the adjoining pantry or hall, being reproduced today for use with systems whereby electric heat is stored up at night. Similar stoves are still in demand for country homes.

In so far as it does not come up to present needs, the cast iron sectional type in Europe is, therefore, also contending with increased competition. But instead of concealed fin heaters we are using freely radiating coils, and where the wall space is limited the pressed sectional steel radiator is now often preferred to the tubular style on account of its easily cleaned surface. However, since the price per square foot is a powerful argument everywhere, the cheaper cast iron pattern of greater depth and height is still prevailing in a very large field. As in the United States, the tubular are replacing the column patterns, but the window radiators seem to be holding their own. In general, it may be said that the sectional radiation for direct heating is applied more nearly in accordance with its original purpose, which met European tradition half way, and that the low and flat patterns are given the preference, as far as the prices will permit. And since the screening is on the wane, the practice is distinctly towards radiant quality, whereas in the United States it appears to be turning to air heating. It is this characteristic difference which explains in good part why Europe gets along with lower room temperatures and that these are by no means to be regarded as a lower standard of heating.

Evidently, more attention is being paid here now to the visible parts of the plants within the rooms. This is not altogether due to the efforts of engineers for economy, efficiency and hygienic quality. It is the present trend in building which helps along because based on similar principles. Architects do not hesitate to show the apparatus when presented as a well finished piece of equipment. This means not only neatness in design. Adaptability of patterns and their proper application are equally important for good engineering, as well as from the builders' point of view.

Other parts of heating plants, particularly the boilers, have always received their share of consideration. The cast iron sectional type, first manufactured in America, was redesigned for coke and for best utilization of the

fuel. Central regulation is favored by water heating and is well developed. Consequently, there is little need for local automatic regulation, particularly where systems are divided in groups and control is facilitated by long distance thermometers. Gravity circulation is the rule for small plants and pumping for large plants, as also for groups and settlements. Until recently, many of these were still heated by stoves, but the idea of centralization is rapidly making headway.

That there is an open mind for progress is shown also by the recent business in blast heating and mechanical ventilation. American practice has aroused considerable interest in this field and recent installations show more or less adaptation. If the majority of the plants are not so complete, it is mainly due to financial and other unfavorable conditions. Very frequently the air supply is omitted, and in many cases the exhaust is by gravity or left to chance, which is not conducive to good results. For competitve reasons, the construction of the air conduits is turned over to the builder as far as possible, thereby increasing the uncertainties of distribution and of temperature control. It is at least partly due to such shifts that hospital and school ventilation have been practically out of demand for some time and are still arousing much opposition. If anything, the situation is worse in this respect than in the United States, but it is interesting that the causes are not the same. One notable difference lies in the fact that European ventilating plants have been calculated for much smaller capacities, three changes per hour being the average for classrooms, which would often account for inadequate performance, while the provision of American ventilating laws calling for 30 c.f.m. per pupil means about nine renewals and is probably the source of many complaints because of excess. However, the recent practice in Europe recognizes the need for greater volumes and that they must also be applied to better advantage. It would lead too far to go into the variety of methods employed in ventilation, of which none could be said to be typical today.

For hot blast, which is gaining ground in the industrial field, the unit heater is now installed extensively. There is a considerable choice of designs, mostly with centrifugal fans. Distributing ducts have never been used to any extent in this class of work, simply because blast heating has come up only after the introduction of manufactured units. The application of this idea to other classes of work, for instance to schools, has not made any headway in central Europe, because the advantages for heating and in many cases for ventilating seem to be questionable. The solution of the problem is sought in a different direction, as previously pointed out.

On account of climatic and other conditions, the need for summer service and cooling is comparatively slight and the cost is generally prohibitive except where an ample supply of cold water is at hand. Air cleaning is done mainly by the dry process, inasmuch as moistening is rarely demanded, but with metal filters, which have supplanted cheese cloth entirely. Air conditioning is generally simplified, not only for reasons of economy.

To sum up, European practice, while readily accepting the practical and advantageous American style of manufactured goods, has nevertheless adapted the same to its own needs and uses them more in accordance with its own traditions, at least in the field where such have been firmly established. Room temperatures are apparently below the American standard, but probably at least equal comfort is attained by means and ways leading in different direction. Air conditioning for special needs and situations is finding application in simplified form in connection with blast heating and ventilating.

Charts for Solving Steam Flow Problems

THE accompanying nomographic charts are designed for determining the pressure drop in saturated steam when passing through a pipe of given diameter, and for determining the velocity of the steam in the pipe when passing a certain quantity at a given pressure through a given diameter pipe. The charts were designed and are copyrighted by George B. Massey.†

Use of the charts will save the designer the solution by tiresome computation. This is especially true of Fig. 1.

The chart shown in Fig. 1 is based on Babcock's formula:

$$W = 87\left(\frac{pDd_1^5}{\left(1+\frac{3.6}{d_1}\right)L}\right)^{1/2}$$

Where w = pounds of steam passing per minute
p = difference in pressure between the two ends of the pipe in pounds per square inch
D = density of steam or weight per cubic foot
d_1 = internal diameter of pipe in inches
L = length of pipe in feet

When the diameter of the pipe, the mean steam pressure, and the pounds of steam passing per hour are known, the solution is found by laying a straight edge through the proper quantities on scales D and P and

†Vice-president, Randolph-Perkins Company, engineers, Chicago, Ill.

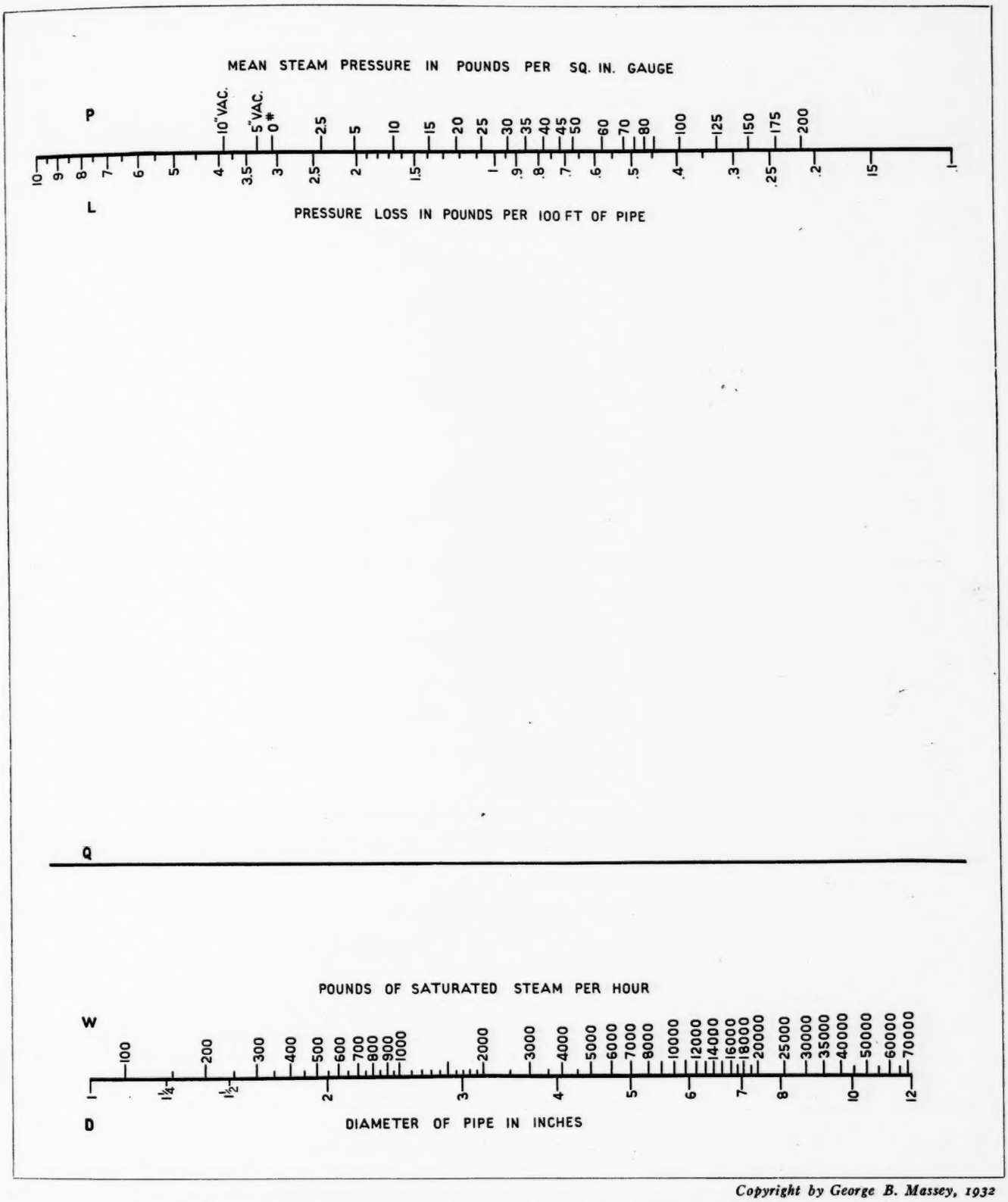


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Fig. 1. Chart for determining pressure drop in steam passing through pipe

locating a point on the line Q. The straight edge is then laid so that it crosses the point on Q and the number of pounds of steam per hour on the scale W. On scale L will be found the pressure loss in pounds per hundred feet of pipe. The scale P is in gauge pressure.

Example: Given a 3 in. steam line passing 4000 lb. of saturated steam at a pressure of 50 lb. per sq. in., gauge. What would be the pressure loss per hundred feet of pipe?

Solution: Lay a straight edge through the figure 50 on scale P and through the figure 3 on scale D, and locate a point on scale Q. Through this point on scale Q and the 4000 mark on scale W draw a straight line which will intersect scale L at 3.75 lb. loss per hundred feet. *In using Fig.* 1, *D and P are always paired, and W and L are always paired.*

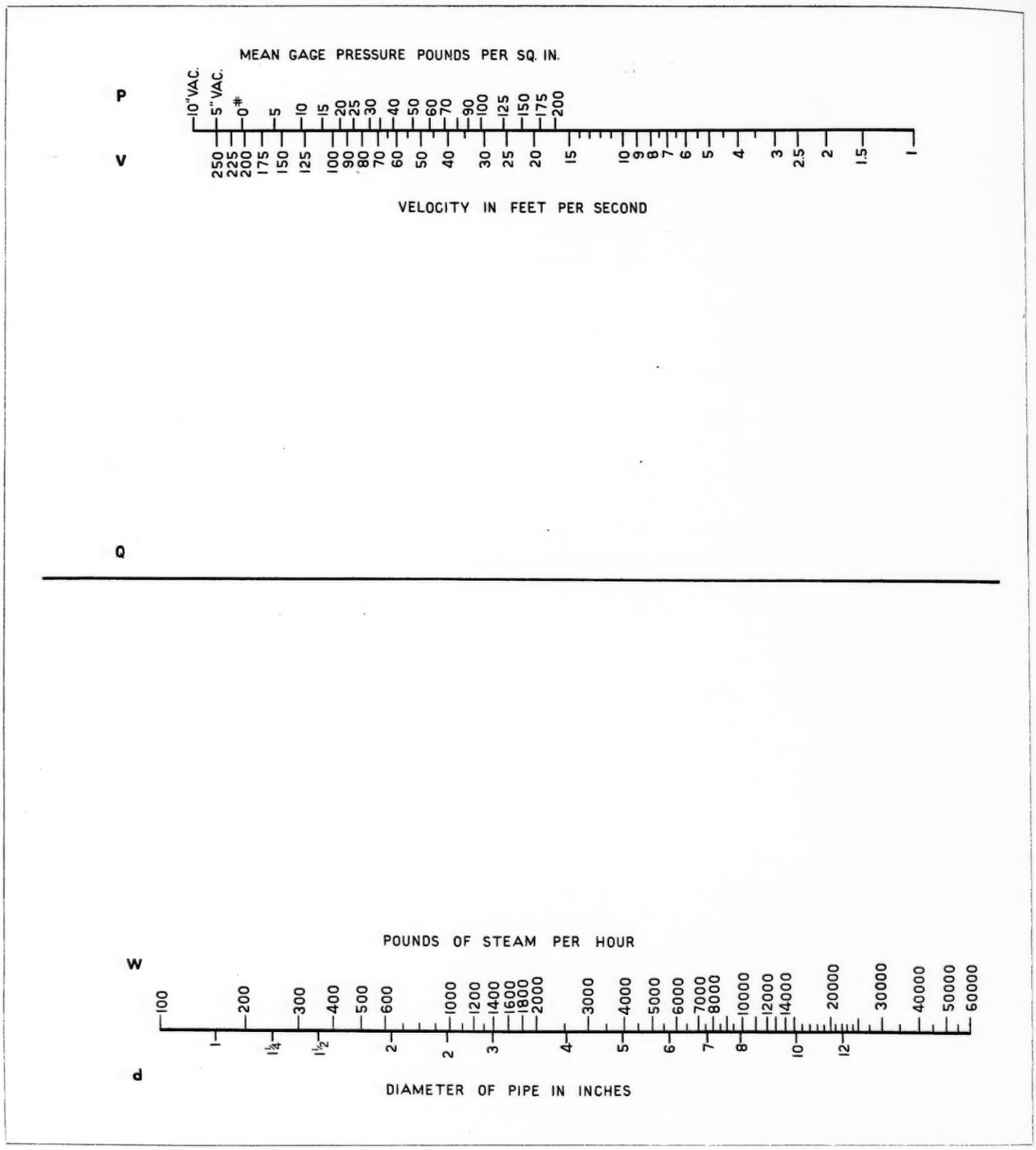

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Fig. 2. Chart for determining steam velocity through pipe

Fig. 2 is based on the formula for velocity of saturated steam in a pipe as given by *Steam*.

$$\text{It is: } V = \frac{9.6w}{\pi d^2 D}$$

Where V = velocity in feet per second
w = flow of steam in pounds per minute
d = diameter of pipe in inches
D = density of weight per cubic foot

In this chart D and P are always paired, and W and V are always paired. Knowing the values of D and P, lay the straight edge so as to intersect the middle scale and the W scale and the velocity can be read on the V scale.

Example: What will be the velocity of saturated steam at a pressure of 70 lb. per sq. in. gauge when 2000 lb. per hr. are passing through a 5 in. pipe?

Solution: Laying a straight edge across the point 5 on the D scale and the point 70 on the P scale, we locate a point on scale Q. Lay the straight edge so that it passes through 2000 on the W scale, and the point we have located on the Q scale and on the V scale we find that the velocity is 21 ft. per sec.

Fan Selection

By CHARLES A. CARPENTER

In a previous article the author set forth a number of mathematical relations pertaining to centrifugal fans. From the formulas developed, charts were illustrated which would permit a simple visual analysis of fan performance if manufacturers would adopt a revised method of plotting performance curves.

This article will point out further reasons why fan performance should be more carefully considered. Some important features of construction will be explained.

In a recent article by H. F. Hagan (HEATING AND VENTILATING, November, 1930) characteristic curves of three types of fans were illustrated. These types were (1) blades curved forward in the direction of rotation, (2) blades curved forward but radial at the tip, and (3) blades curved backward to the direction of rotation (See Figs. 1, 2, and 3). As these curves were all plotted on a percentage basis, they may be considered as typical of the three designs without specific reference to size or to r.p.m.

Analyzing these curves by means of the formula for specific speed

$$\text{Specific speed} = \frac{\text{r.p.m.} \sqrt{\text{c.f.m.}}}{79.72\ (\text{wg})^{\frac{3}{4}}}$$

we can obtain the relations between relative specific speeds and static efficiencies. Fig. 5 shows such curves with the best specific speed plotted as 100. The actual best specific speeds may be various numbers depending upon the design of the fan, its width, and other factors. However, the curves clearly show the cramped range and low efficiency of the forward curve fan, the better characteristics of the radial tip wheel and the fine performance of the backward curve fan.

If we examine these curves, we find that for any desired efficiency, the forward curve fan has the least range in specific speed and the backward curve fan has the greatest range. This range determines the available speed ratio to meet specific requirements of capacity and pressure.

Table 1 shows the range in speeds for various efficiencies for the three fan types. Fig. 4 is based on Table 1.

From this we see at a glance that maximum efficiency is obtainable at one speed only for any type of fan to meet fixed capacity and pressure requirements.

If the available speed range is two to one, such as a choice between motors at 750 r.p.m. or 1500 r.p.m., we might expect a forward curve fan efficiency between 48.5% and 60%, a radial tip fan efficiency between 56% and 66%, and a backward curve fan efficiency between 64.5% and 74% if proper fans can be selected.

On the other hand, if it is desired to deliver some fixed quantity against a known water gauge with at least 50% static efficiency, the available ranges in speed are:

Forward curve fan	= 1.81
Radial tip fan	= 2.63
Backward curve fan	= 3.64

In this case the backward curve fan offers twice the opportunity afforded by the forward curve design.

It must be understood that many fan problems involve specific speeds beyond the range of good efficiency for any fan. This is particularly true of large capacity low pressure fans direct connected to motors of too high r.p.m., or to high pressure blowers direct connected to slow speed motors.

Table 2 shows some brake horsepower figures for various air horsepowers and efficiencies.

As commercially offered, fans have a limited range of best specific speeds. The writer published some

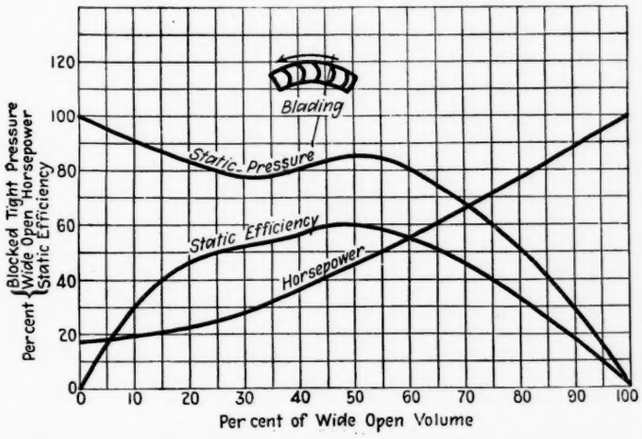

Blading
Static Pressure
Static Efficiency
Horsepower
Per cent {Blocked Tight Pressure / Wide Open Horsepower / Static Efficiency
0 20 40 60 80 100 120
0 10 20 30 40 50 60 70 80 90 100
Per cent of Wide Open Volume

Fig. 1. Characteristic curves of forwardly-curved blade fan

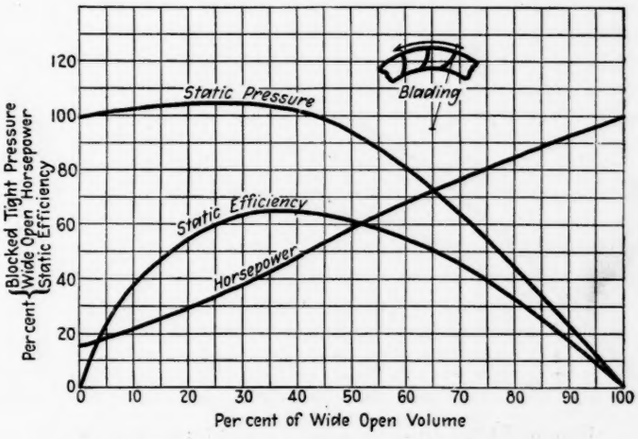

Static Pressure
Blading
Static Efficiency
Horsepower
Per cent {Blocked Tight Pressure / Wide Open Horsepower / Static Efficiency
0 20 40 60 80 100 120
0 10 20 30 40 50 60 70 80 90 100
Per cent of Wide Open Volume

Fig. 2. Characteristic curves of radial blade fan.

figures showing this in previous issues of HEATING AND VENTILATING.

Without any reference to the fan curves given in Mr. Hagan's article cited above, let us assume that a forward curve fan design is available with a best specific speed of 500, and a backward curve fan design may be obtained with a best specific speed of 300. If the actual conditions call for a specific speed of 1000, the forward curve fan might be expected to give around 48.5%, whereas the backward curve fan should operate at approximately 52.5%.

The foregoing statements have been given to show the need of careful analysis of fan problems leading to the selection of the best economic unit.

Most fan problems involve estimates of both capacity and water gauge. Hence, there are doubts as to performance in actual service. It should be evident that good results may be insured by following sensible procedure. The following is suggested:

First, careful estimates should be made of required volume, water gauge, temperature, density of gases handled, and other factors pertaining to the job.

Second, speed requirements should be as flexible as possible considering operating conditions, in order that fan manufacturers may offer suitable equipment.

Third, fan characteristics should be studied and performance curves rated in accordance with the reputation of the companies or individuals responsible for the curves.

Fourth, it should be borne in mind that fans of all manufacturers perform quite similarly as to type although actual details of performance may vary widely. That is to say, all forward curve bladed fans have marked characteristics quite different from backward curve blading.

Having studied the mathematical phases of a problem, practical features must be taken into account.

Details of design should be studied so that due credit is given to those features which affect efficiency and performance.

Fan inlets should be well proportioned and may include guide vanes to reduce inlet losses. Seals may be furnished to prevent back flow at the inlet. Obviously, improved inlet design and sealing are more important in pressure blowers than in low pressure, low inlet velocity ventilating fans.

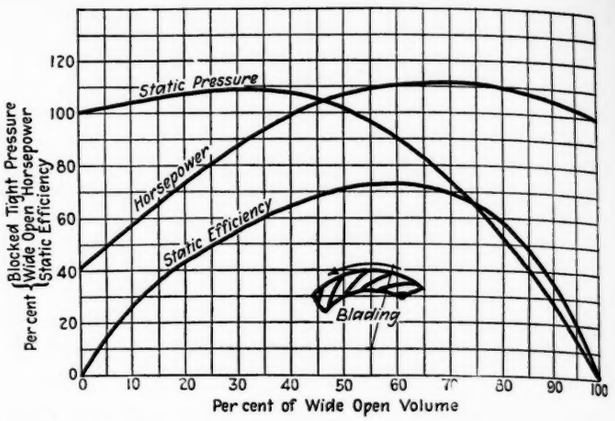

Static Pressure
Horsepower
Static Efficiency
Blading
Per cent {Blocked Tight Pressure / Wide Open Horsepower / Static Efficiency
Per cent of Wide Open Volume

Fig. 3. Characteristic curves of backwardly-curved fan.

Wheel blading at the inlet is important because it influences efficiency and capacity.

Fan blades should be shaped uniformly and smoothly so that the building up of pressure and velocity is gradual and smooth. The effect of blade curvature at the wheel periphery has been fully discussed.

Fan casing design is highly important. Since the casing or scroll acts as a diffuser or as a means of converting velocity energy into pressure energy, the scroll should permit a gradual uniform slowing down of the air from the time it leaves the impeller until it passes from the fan discharge outlet. The point of cut-off must be properly located to prevent eddies and by-passing of the air. The running clearance between the wheel and the sides of the housing must be such that windage losses are kept at a minimum.

Fan outlet design has a large bearing on the actual results obtained. It must harmonize between desirable scroll dimensions and duct cross section. Outlet openings obviously made large with widely diverging flared

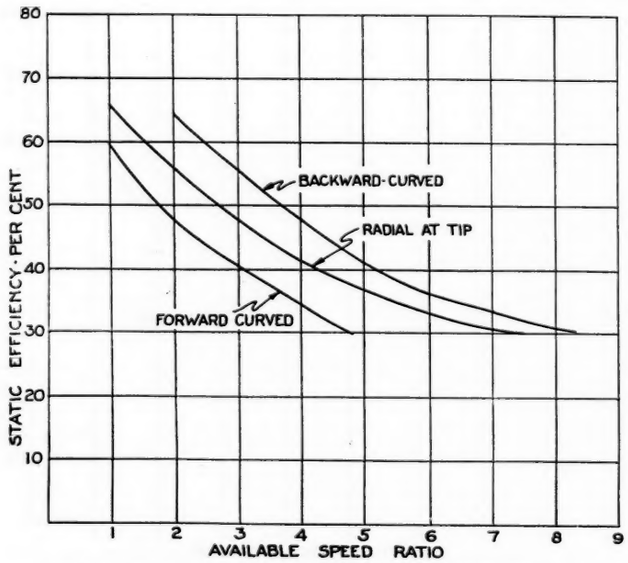


Fig. 4. Range in speeds for different efficiencies of different fan types.

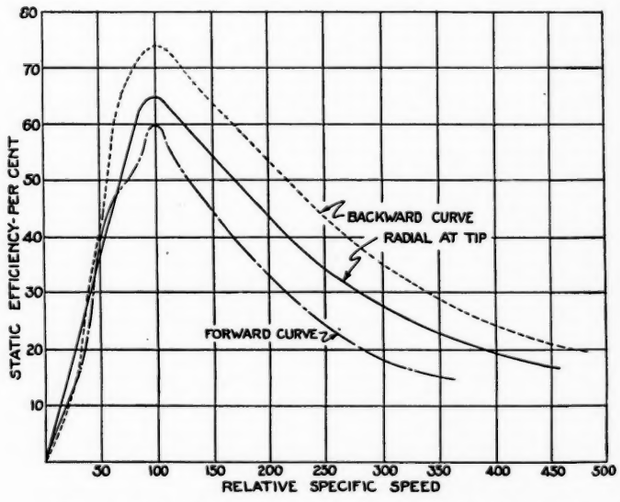


Fig. 5. Relation between specific speed and static efficiency with that specific speed at 100.

TABLE 1

AVAILABLE RANGE IN R.P.M. AT VARIOUS STATIC EFFICIENCIES TO DELIVER A FIXED VOLUME AT A FIXED PRESSURE

Static Efficiency at least	Forward Curve	Radial at Tip	Backward Curve
30	4.81	7.29	8.28
40	3.14	4.20	5.20
50	1.81	2.63	3.64
55	1.31	2.12	3.14
60	1.02	1.58	2.55
65		1.11	2.05
70			1.52
74			1.

TABLE 2

BRAKE HORSEPOWER AT VARIOUS EFFICIENCIES

	Horsepower in the air				
% Efficiency	10	20	30	40	50
30	33.3	66.7	100.	133.3	166.7
40	25.	50.	75.	100.	125.
50	20.	40.	60.	80.	100.
55	18.2	36.4	54.6	72.8	91.
60	16.7	33.3	50.0	66.7	83.3
65	15.4	30.8	46.2	61.6	77.0
70	14.3	28.6	42.9	57.1	71.4
74	13.5	27.0	40.5	54.	67.6

sides should be avoided. They frequently account for erroneously high test results and generally reduce actual efficiencies.

At the best, air velocities at the fan discharge are not uniform. Attempts to show very low velocities by flaring the outlet too rapidly accentuate turbulence and irregular air flow.

Since centrifugal fans frequently operate at high speed with heavy rotating parts, revolving on bearings far apart, the subject of critical speed enters numerous fan problems. A few dollars spent on extra shaft stiffness, more perfect dynamic balance and high class bearings may mean the difference between a successful operating unit and a failure.

In present industrial practice fans are called upon to meet increasingly difficult conditions. Manufacturing practices may call for high temperature gas circulation; boilers at high ratings, equipped with stokers, preheaters, etc., may require high pressure fans.

Annoying sounds are being watched more closely, perhaps influencing fan manufacturers to redesign their product.

In conclusion, it may be stated that fan engineering is based on rather simple theories and mathematical analysis, enabling engineers to use ordinary common sense to make a proper purchase. Every effort should be made to remove the air of mystery and to exercise sound judgment.

Radiator Output Tested at Swiss University

ACCORDING to a report published abroad[1], tests conducted by M. Hottinger in the Swiss Technical University, at Zurich, furnished results showing that the unit heat emission of a flat wall radiator was considerably greater when standing against an interior wall than that of a "normal" radiator. The author, who is a consulting engineer and an instructor in the university, conducted the tests during February and March, 1931.

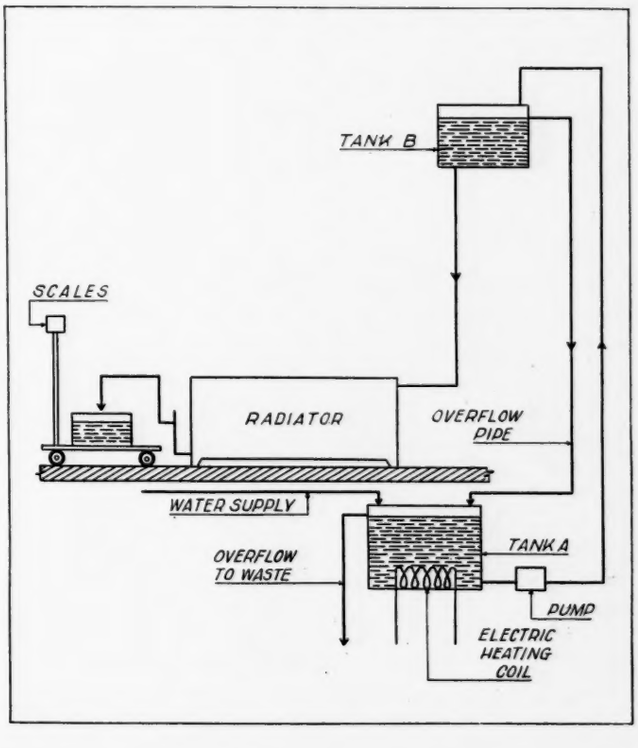
The author describes the testing room as being about 12 ft. x 15 ft. x 8 ft. high with wainscoted walls and with a shingle covering on the outside. The testing room is not enclosed in a refrigerated chamber and, consequently, the tests were conducted on cold days with the heat flowing through the walls under the influence of the outside temperature depression.

As the radiators tested do not correspond to those of American manufacture, the results, while important, are probably not applicable to our conditions.

The method of testing and the device used for securing a supply of hot water are different from those commonly used in this country and are worth attention.

In testing, two radiators were set up side by side in the same room and were supplied with hot water from a common source. The mean water temperature in each radiator was thus kept the same, and as each stood in the same temperature air the test conditions were considered comparable. The effectiveness of the radiator was judged by its ability to emit heat to the air. Readings of the air temperature were made at a point about 6 ft. from the radiator and were used as a control. The results are not analyzed on the basis of floor to ceiling temperature gradient. The effect of position in the room was studied by testing the radiators both under a window and along a cold wall.

The method of supplying hot water to the radiators is shown in the drawing. Water heated by submerged electric coils in the heavily insulated tank A under con-



[1] "Investigations Regarding the Heat Output of Radiators," *Gesundheits-Ingenieur*, August 22, 1931.

trol was pumped to the insulated tank B from which an overflow pipe returned surplus water to tank A. The pump was oversize and pumped an excess of water to tank B. This had the effect of keeping up a circulation and helped to keep water in tank B at a nearly constant temperature. Both the electric heater and the rate of flow of water were subject to hand control. Water flowed from the tank B to the radiators to be tested and was weighed after passing through. Temperature readings at inlet and outlet permitted a record of the mean water temperature being kept. The author included data in his paper showing that the temperature in each radiator was successfully controlled by this method.

The tests included only certain direct radiators. These were of several patterns, styles, heights and lengths. It was found that the unit heat emission of a flat wall radiator was considerably greater when standing against an interior wall than that of a "normal" radiator. The increase is explained as being due to increased transfer by radiation. The author compared his results with those used by German engineers for design purposes and found that those in use may be regarded as conservative.

Unusual Oil Burner Control System

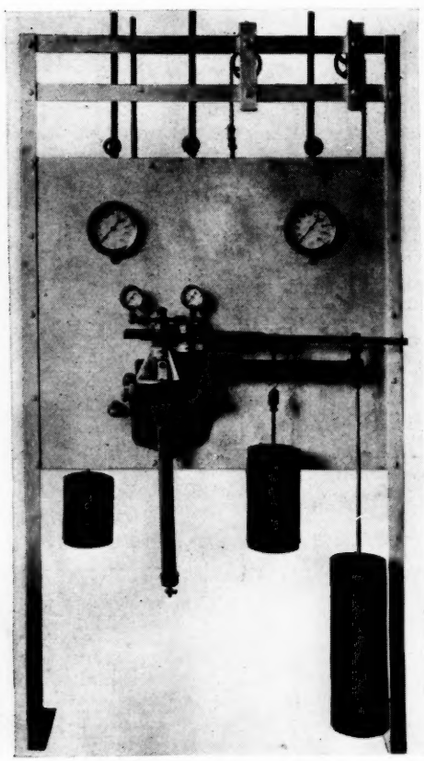
ACCOMPANYING photographs show a system of regulation for the control of oil feed, recently installed in a large hospital in Brooklyn. The unit consists of a panel containing a master steam regulator mounted on one side of the panel and a pressure regulator on the other side. The photographs show both sides of the same panel.

The units are so mounted that the master steam regulator has control over the oil or pressure regulator by actuating a pinion which is clearly visible in the photographs. Two pinions are mounted on a horizontal shaft engaging the compensating rack on both regulators. That is, there is a pinion on each end of the shaft, as shown in the photographs.

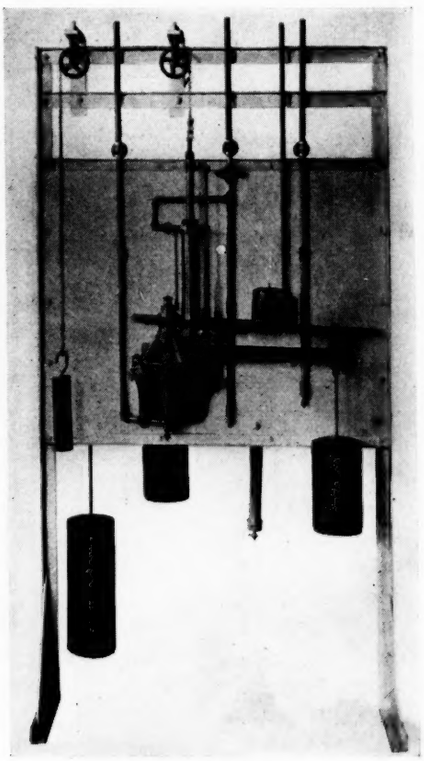
This combination has been developed for varying the oil pressure in any desired ratio with changes in the steam pressure, the regulation being accomplished either by controlling the speed of a steam-driven oil pump or by the control of an oil discharge line relief valve where a constant speed electric pump is used. The regulators are hydraulically operated, employing city water pressure as the medium of operation. They are extremely sensitive and consequently accurate within a small fraction of a pound.

It will be seen that with an increase in steam pressure, it may be desired immediately to decrease the oil pressure, and as explained above this may be accomplished in any ratio or range.

To make all details clear it might be well to point out that the racks, upon pressure changes, travel in opposite directions. Thus, while the rack on the master steam regulator travels outward, adding additional weight to compensate for an increased pressure, the rack on the oil or pressure regulator travels inward, in the opposite direction. The result is that the adjusting weights travel back toward the fulcrum, thus reducing the pressure at which the regulator will actuate the pump - governing valve. The photographs clearly indicate these things — that the traveling weights and their position govern the oil pressure to the burners.



Front of panel.



Back of panel.

This system can be extended by adding thereto one additional pressure regulator, making the system applicable for controlling, through the master steam regulator, the steam atomizing type of oil burner. One of the pressure regulators would actuate a governing valve, and would have control of the steam pressure to the burners, while the second unit would control the oil pressure. While the steam and oil pressure regulators would, through changes in the boiler pressure, be controlled by the master regulator, each may be independently adjusted to maintain any predetermined ratio that may be required for proper atomization.—*W. F. Schaphorst.*

A Method for Determining Fuel Burning Rates in Heating Boilers Fired by Automatic Devices

By R. C. CROSS†

THE rate at which fuel must be burned in a heating boiler is influenced by several factors such as fuel characteristics, method of fuel burning, boiler performance, etc., but fundamentally it is determined by the radiation load necessary to compensate for the heat loss of the building. As the following discussion is founded upon this basis, it is assumed that radiation of the proper amount is a known factor.

A recent study of a number of installation manuals for automatic firing devices indicates an apparent lack of uniformity in applying heating load factors to obtain fuel burning rates. Various percentage values, ranging from 15% to 30%, were given for allowance for piping. Only in a few instances was specific allowance made for pickup load demands. With few exceptions it seems desirable that a proper pickup allowance be made in setting the rate of fuel burning with automatic devices. This is particularly true of "on-off" types of oil or gas burners.

Fig. 1 indicates percentage allowances for *piping* and *piping and pickup* to be applied to net load or *actual radiation load* values. The values given are believed to be conservative and applicable to the average installation, although varying conditions as to insulation, pipe covering, load demands, etc., should be compensated for by suitable modification of the allowances.

Gross output values, or total tax on the boiler, resulting from the application of the above allowances have been worked out and may be found directly by use of Fig. 2 or 3.

It will be noted that the hot water supply load, if present, is included in the net load value. The following equivalents, which are on a *net* basis, are helpful in expressing hot water load in terms of direct radiation:

Submerged heater with storage tank

0.8 ft. steam radiation per gallon water tank capacity.
1.3 ft. water radiation per gallon water tank capacity.

Submerged heater without storage tank

3.0 ft. steam radiation per gallon water tank capacity.

Steam coil in storage tank

1.5 ft. steam radiation per gallon water tank capacity.

Having determined the gross output, the fuel burning rate then can be found from one of the following charts, dependent upon the fuel utilized. In using the fuel rate charts consideration must be given to a third factor, which is the overall efficiency of the boiler and firing device. This factor calls for some thought as to the degree of efficiency to be expected from the particular installation at hand. The efficiency of automatic firing devices is fairly high, as most of these

† Supervising Engineer, The H. B. Smith Company.

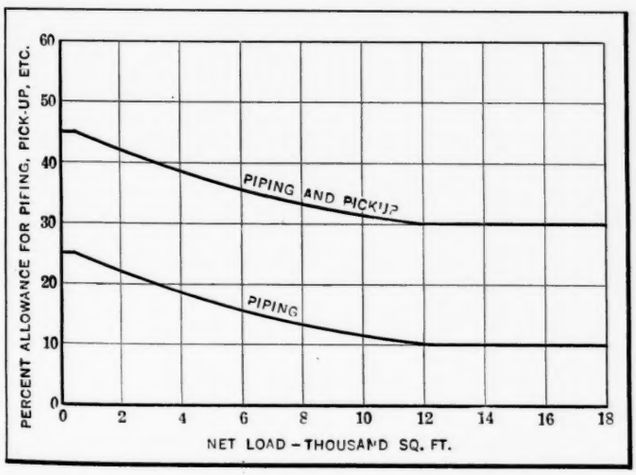


Fig. 1. Percentage allowance to be added for piping and piping pickup

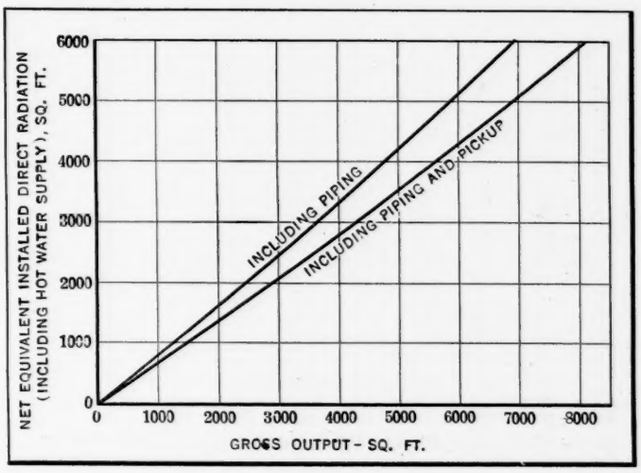


Fig. 2. Gross output values for boilers up to 6000 sq. ft. of radiation

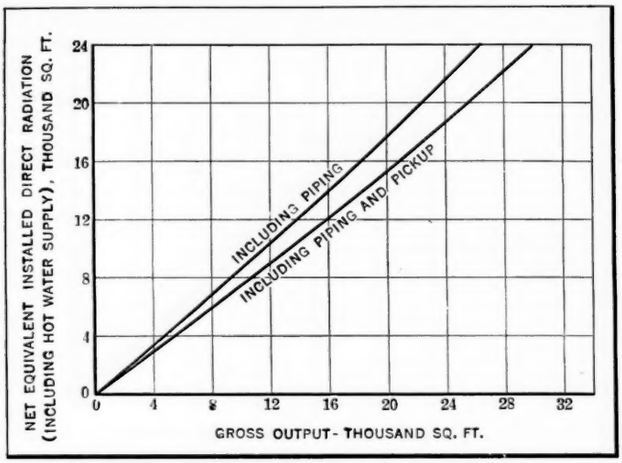

NET EQUIVALENT INSTALLED DIRECT RADIATION (INCLUDING HOT WATER SUPPLY), THOUSAND SQ. FT.
INCLUDING PIPING
INCLUDING PIPING AND PICKUP
GROSS OUTPUT - THOUSAND SQ. FT.

Fig. 3. Gross output values for boilers up to 24,000 sq. ft. of radiation

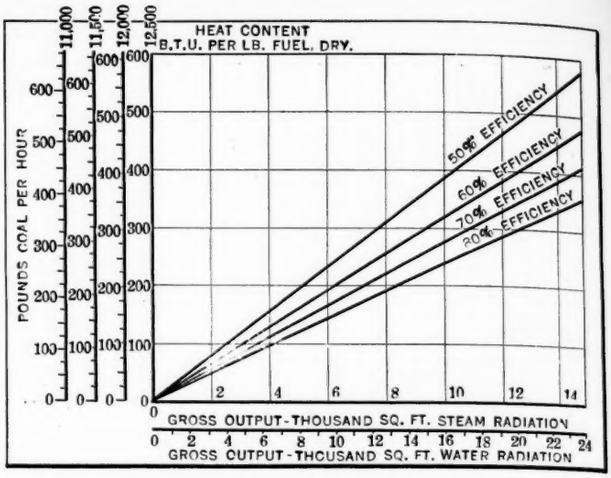


Fig. 4. Rates at which solid fuels must be burned in stokers for domestic boilers

units possess the ability to maintain good combustion. Boiler efficiencies will vary more widely, dependent upon load, type, size, and other factors. Special boilers for automatic firing, properly rated, are capable of operating at 70% to 80% efficiency, or even better, while an undersized hand-fired boiler converted to automatic firing may show as low as 50% efficiency. In using the charts which follow, the heating engineer will have to exercise some judgment as to the efficiency value to be used.

Fig. 4 shows the rates at which solid fuels of various heat contents must be burned in stokers for firing domestic boilers.

Fig. 5 has been prepared to show rates for use with oil burners.

The above chart is based on No. 3 oil since 54% of the burners listed in a recent survey and analysis use this grade of oil. However, the following table of conversion factors may be used when other grades of oil are burned, assuming that the same quality of combustion can be attained.

The rates for burning gas are shown in Fig. 6, values being given for both natural and manufactured gas.

As an illustration of the use of the above charts, assume a direct radiation load of 1000 ft. steam plus a hot water load of 200 ft. equivalent direct radiation (250 gal. tank submerged heater, 250 x 0.8 = 200). This gives a total net load of 1200 ft. Referring to Fig. 1 an allowance of 43.5%, to take care of piping and pickup, is recommended, and from Fig. 2 we get a gross output of 1720 ft. Assuming an overall efficiency of 80% and referring to the various charts, the fuel rates for this output are found to be 41.2 lb. coal per hour (12,500 B.t.u. heat value); 3.66 gal. oil per hour (No. 3 oil) or 515 cu. ft. gas per hour (natural gas).

The method outlined above is suggested as being a fair basis for determining fuel burning rates and is offered in the hope that it may be of some assistance to heating engineers in solving this particular phase of automatic heating.

TABLE 1
OIL CONVERSION FACTORS

Oil Grade No.	Gallon factor	Pound factor
1	1.038	0.988
2	1.018	0.995
3	1.0	1.0
4	0.974	1.010
5	0.95	1.017
6	0.928	1.028

Note—Multiply rate given on chart by proper factor to find equivalent rate for other grade of oil.

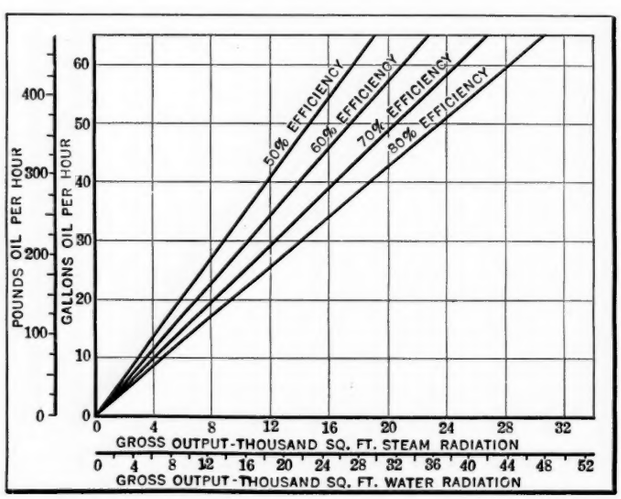

POUNDS OIL PER HOUR
GALLONS OIL PER HOUR
50% EFFICIENCY
60% EFFICIENCY
70% EFFICIENCY
80% EFFICIENCY
GROSS OUTPUT - THOUSAND SQ. FT. STEAM RADIATION
GROSS OUTPUT - THOUSAND SQ. FT. WATER RADIATION

Fig. 5. Fuel-burning rate chart for oil burners in domestic boilers

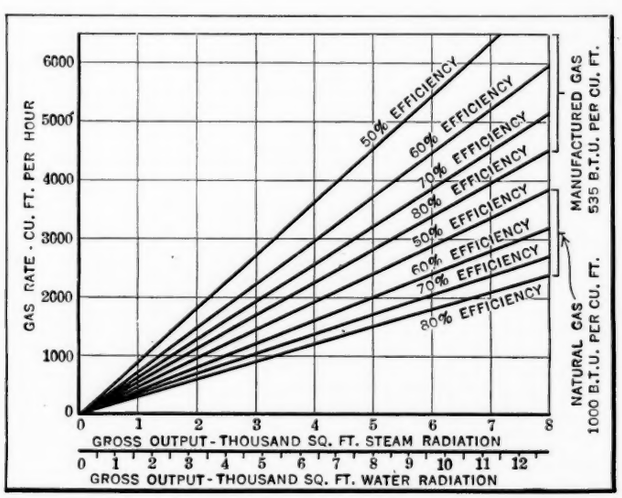

GAS RATE - CU. FT. PER HOUR
50% EFFICIENCY
60% EFFICIENCY
70% EFFICIENCY
80% EFFICIENCY
MANUFACTURED GAS
535 B.T.U. PER CU. FT.
NATURAL GAS
1000 B.T.U. PER CU. FT.
GROSS OUTPUT - THOUSAND SQ. FT. STEAM RADIATION
GROSS OUTPUT - THOUSAND SQ. FT. WATER RADIATION

Fig. 6. Fuel-burning rate chart for manufactured and natural gas

Opportunities for Welding-Trained Men in Metal Working Trades‡

By DR. S. LEWIS LAND†

WELDING, probably more than any other single factor, has contributed its share to change in the direction of progressive development in the basic metal trades and industries during the past decade. Over the period of the last five years rapid progress has been made in the welding of pipe in oil lines, heating installations, and piping in power plants. Welding is being rapidly accepted by building owners, engineers, and heating contractors in the installation of heating and other piping. A list of the buildings in which welding has been employed for the pipe installations would be too long to enumerate here. Among recently constructed office buildings in which the pipe has been installed by welding, we may mention the Chrysler Building and Empire State Building in New York, the Carbide and Carbon Building in Chicago, and the Fisher Building in Detroit; among hospitals in New York there are the new Cornell Medical Center, several additions to the Bellevue Hospital, and the Presbyterian Medical Center at Columbia University; among churches there is the Cathedral of St. John the Divine in New York, which represents one of the biggest undertakings of this kind which we have; and among educational institutions is the heating plant at the University of Chicago, the heating plant at Dartmouth College, a power plant at New Hampshire State College, and many elementary, junior high, and high schools too numerous to mention.

Some years ago when the square butt weld was used in pipe installations, there was some merit to the objection of welding smaller size pipe because of the icicles clinging to the inside of the pipe which resulted from this type of joint. Because of the particular type of joint, the formation of icicles was beyond the control of the operator. Because of this the specifications of our association prohibit the use of the square butt joint and insist upon the single vee type joint. There is no mechanical reason, with the use of this type of joint, why welding cannot be done just as advantageously in smaller size pipe as on the larger sizes.

Several reasons have contributed to the rapid growth of pipe welding. Some of these will be briefly discussed.

Factors in Design

Proper design of a piping system involves a great many considerations which must be weighed in proper relation to their respective importance on a particular job. First, cost is an important consideration, but not the most important one. Maintenance and replacement costs, general practicability, general bulk and weight of the materials in relation to space available, the possibility of making installations quickly and, at the same time, in a first class manner are a few of the items that must have careful thought and study. In present day piping practice, appearance is also an important consideration.

First cost. Welding assures lower first costs in the larger pipe sizes. This is especially true where it is necessary or desirable to make a number of connections within a confined or limited area, as is the case in header construction. Lower first costs are also frequently possible on the smaller pipe sizes when the work is of sufficient quantity and of such a nature that the welding crew or crews can be continually at work without interruption and where their time does not overlap the time of other crews doing the actual placing of materials.

Until very recently there was a general opinion that it was not economical to weld pipe below 2 in. or 2½ in. in diameter. Those in our group, however, who are using welding extensively believe that there is no real reason to justify this original conception. We believe that welding provides an economical installation. The real economy, however, is possible through the utilization of the maximum amount of welding, including all pipe sizes.

Maintenance cost. Welding eliminates screwed and flanged joints which results in lesser maintenance cost. Experience has shown that a welded joint properly designed and made is far less likely to give trouble as time goes on than are screwed or gasketed joints.

Bulk and weight. Table 1 gives data which are typical of savings in weight and bulk effected by welded construction. The basis for these data was a pipe welding installation in one of the Bureau of Standards buildings in Washington.

TABLE 1

SAVINGS IN WEIGHT AND BULK EFFECTED BY WELDED CONSTRUCTION

	Weight, Lb.	*Percentage Ratio*
Boiler header piping originally designed for flanged steel fittings	17,700	100
Welded boiler header piping installed	10,500	60
Flanged steel fittings including bolts but no auxiliary flanges	6,500	100

‡ Abstracted from a paper read before the thirty-second annual convention, International Acetylene Association, Chicago, November 11-13, 1931.

† Educational Director, Heating and Piping Contractors National Association, New York.

Short radius fittings and pipe used for intersection welds to replace flanged fittings	1,050	16
Steel flanges necessary for installation	3,700	100
Welding neck flanges installed and taking full advantage of flanges that welding eliminated	1,950	48

The item of general bulk and weight is considerably simplified by the use of welding. Cast fittings and flanges represent a major portion of this item in the non-welded installation. Frequently, the physical space that would be necessary to use flanged or even screwed fittings is not available. To provide this space might in some cases mean increased cost in building construction, to say nothing of the increased cost of the piping work itself. With reduction in bulk naturally goes reduction in weight, the advantages of which are self-evident. There is a considerable saving in the cost of hangers and other structural material necessary to properly support the various parts of the installation.

The frontispiece in this issue is an unusual view of the air conditioning system in the Eastman Kodak Company's plant, which contains the largest refrigerating system in the world. Every room in which film and paper are sensitized and handled is maintained at uniform temperatures and humidity conditions. The photograph is by H. L. Irwin, and is reproduced through the courtesy of "Applied Photography," published by the Eastman Kodak Company.

Time. Welding can advantageously be employed to render quick service in fabricating materials without the necessity of long delays while waiting for various pieces of equipment to be set in order to take measurements. This is accomplished by having tie-in pieces made long and then cut and welded into place on the job. If welding neck flanges or lap joint flanges are to be used, it is always possible to provide a piece of pipe having a welding neck flange or lap joint flange on one end and beveled on the other end for insertion adjacent to valves or similar flanged connections. It is also possible and practical to fabricate special fittings. This procedure usually saves considerable time and expense, as it avoids delays in waiting for cast fittings to be made.

Alteration. Oxy-acetylene cutting frequently can be used to advantage in making openings for new branches in existing piping. There may be a saving in both material and labor cost. There may also be an advantage to the owner with regard to the time of shutdown for the line to be cut.

Underground lines. Welding has an especially practical and economical place in connection with underground pipe lines. The advantages already mentioned are frequently much more important in this class of work and, therefore, of greater relative value on an underground line than would be the case with an exposed line. The question of elimination of joints underground naturally is of prime importance. The proper insulation of underground work must naturally be seriously considered and is simplified by welded construction.

Insulation. Welded construction also provides a very definite advantage in insulation of inside piping as well. Outwardly, the advantage is, of course, the possibility of making a very smooth covering job. The heat radiating surfaces on a welded job are considerably less than they would be were flanged or screwed fittings used, thereby presenting a proportionately less amount of radiating surface after covering has been applied. There is an advantage in first cost of insulating welded lines, particularly where it would be required to insulate flanges.

We believe these are the major reasons for the rapid growth of pipe welding and adequately justify the activities of our association, whose program in this field I shall briefly review.

Standards and Specifications

In order to regulate and standardize the application of fusion welding in the piping industry and to provide economical and uniform methods of weld tests, our committee on welding prepared our "Specifications and Standards Covering Welding of Steel and Wrought Iron Pipe," and these specifications and standards have been approved by our committee on standards and adopted by the national Association. These specifications cover the requirements for fusion welding of all steel and wrought iron pipe for steam and process piping operating at pressures not exceeding 250 lb. per sq. in. and at temperatures not exceeding 406°. A short form specification has been prepared and made available to architects and heating and ventilating engineers which they may add or incorporate in any general specification for a piping installation.

Standard Manual on Pipe Welding

As a next step in our program in welding, we prepared the *Standard Manual on Pipe Welding,* which serves as a handbook and reference volume for contractors, as a manual of procedure for journeymen, as a reference volume for consulting engineers, and as basic text material for schools in their training programs for journeymen steamfitters.

Promotion of Training Programs

With the formulation of our standards and specifications and the completion of the manual, our next major problem was that of the training of an adequate number of men to do welding. We are in accord with the American Federation of Labor in their belief that welding belongs to the trade in which it is being done. In other words, we do not believe that it is either economical or desirable to have welding specialists aside from our regular journeymen. On the basis of this belief, our program involves the training of our present journeymen steamfitters to handle a new tool, the welding torch. This we are doing not through training programs, which we will set up and operate ourselves, but through the already established educational agencies responsible for this specialized task. In the beginning, our committee formulated a series of five standards for

the guidance of our local associations and the state and local school officials with whom they would cooperate in the organization and maintenance of these training programs, looking not so much to standardization in this particular field but to the maintenance of certain minimum standards. These standards are:

1. Instruction should be given first to journeymen fitters.

2. School authorities should furnish adequate accommodations for instruction as specified in the recommendations of the Heating and Piping Contractors National Association, including a floor area of not less than 1,000 sq. ft. to provide for classroom with tables and chairs, shop equipped with necessary apparatus and tools, and adequate teaching equipment.

3. The school should employ instructors who preferably are not only expert steamfitters, but possess welding skill and knowledge, and who are also trained as instructors—the minimum training and experience to be the equivalent of that required for shop and related subjects instructors in the State Plans for Vocational Education.

4. The course of study should meet with the approval of the Heating and Piping Contractors National Association. The basic textbook should be the *Standard Manual on Pipe Welding*, published by the Heating and Piping Contractors National Association.

5. Close relations should be maintained between the school and the industry through a joint commission that has an actual share in the shaping up of instruction in the school, as well as control of training conditions outside the school.

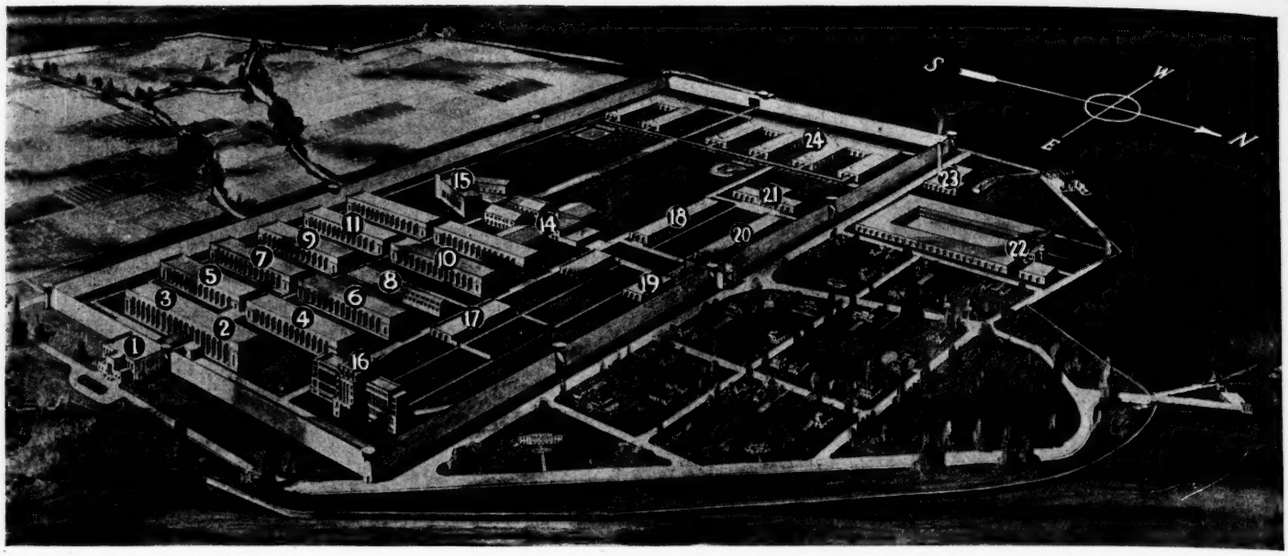
While we have no quarrels with any local group who set up their own training program, such as a training program under the auspices of a local journeymen's union or a private welding school, if our people have first gone to the local school authorities and failed to get adequate cooperation, we do believe that best results are obtained through cooperating with the already established public educational agencies. In too many cases where journeymen steamfitters' unions have started programs, for various reasons such as a lack of financial support to carry through and lack of specialized administrative and supervisory facilities, training programs which have been started have been dropped in their early stages.

If we examine more closely these five standards we note that the program provides for participation of all three interests—the employer, the journeymen, and the schools—through a joint commission which is appointed by the several bodies and made responsible for the shaping of policies and the maintenance of contact with the school. This commission has such responsibilities as the making of surveys; determining needs for training; the formulation of rules governing admission to the training program; securing adoption of these rules by the various cooperating bodies, including the board of education; enrolling, testing and approving applicants for training; maintaining contact continuously with the school; providing for supervision of work and training; enforcing regulations; hearing and deciding complaints; and certifying the results of training.

Such a set-up as this is not new, but has been tried out throughout the country, particularly in Wisconsin, New York, Massachusetts, California, and other states.

Selection of Trainees

These standards further provide that instruction shall be given first to journeymen fitters. In other words, we believe that before instruction is made available to our apprentices and those not already engaged in the trade that our immediate needs should be met. We do not believe that every journeyman should be trained in welding. Unfortunately, in our industry no provision has been made for the superannuated journeymen and we have as a result some men approaching the ages of 65 and 70 who probably will never learn to be welders and no attempt should be made to train them as welders. We have others who are working in organizations where such a limited amount of welding is done that a very small part of the time of the entire working force is in the field of welding that each man would not be able to keep in constant trim. In these cases, we believe that a limited number, possibly ranging from 10 to 50% of those employed by any one contractor, the number depending on the amount of welding he does, should be selected and trained as welders and that the contractor should use these journeymen fitters as welding specialists.



Sloan and Robertson, Architects — *Clark, MacMullen and Riley, Heating and Ventilating Engineers*

Plot diagram of Riker's Island Penitentiary.

1—Administration Building
2—Receiving Building
3—Detention Building
4, 5, 6 and 7—Cell Blocks
8—Bathhouse
9, 10 and 11—Cell Blocks
14—Mess Hall
15—Chapel
16—Hospital
17—Laundry
18—Storehouse
19—Garage
20 and 21—Maintenance Building
22—Warehouse Building
23—Power House
24—Shops

Ventilating and Heating a Large Prison

By ALBERT F. McCLURG

A prison, for which the heating and ventilating alone will cost over a half million dollars, is being erected on Riker's Island, in New York. The capacity will eventually be 3000 prisoners. Due to the special character of the building the heating and ventilating constituted an unusual problem.

RIKER'S ISLAND, New York, is located in the East River near its junction with Long Island Sound. Being within sight of the Boroughs of Bronx, Manhattan and Queens, but separated from them by water, it is favorably located as the site for the new city penal institution.

Theories regarding the surroundings and treatment of convicts have gradually grown up condemning the crowding of prisoners and their housing in dark and sombre buildings. These ideas are embodied in the design of the prison. For example, one of the outstanding points in the plan is a recognition of the fact that crowding of prisoners is not in line with present-day penal ideas. Instead of providing for 400 to 600 prisoners in each cell house of five tiers, as has been the custom in the past, each cell house is planned to accommodate only 240 prisoners.

Modern ideas of penology also recognize the necessity for keeping prisoners occupied. Shop buildings for this purpose are included in the project.

The architects have endeavored to present a design, simple, and at the same time economical in composition, which will be entirely practical, fireproof, and cheerful in outward appearance. As a result the prison buildings are planned in light colored brick with stone trim. A general view of the whole project is shown in Fig. 1. Instead of the concrete wall shown in the illustration, a wire fence has been planned to surround the enclosure.

Fig. 2 is a ground plan of the area covered by the prison from which the orderly arrangement of the buildings and the care used in the development are evident. The general plan locates all the necessary buildings having to do with the prisoners inside the walls, while officers' residences and power and service facilities are located outside the walls close to the ferry slip to facilitate communication with the outside and the ready handling of material.

One of the points given attention during the course of the design is the matter of adequate provision for

future expansion. The final plan not only includes locations for projected buildings but the equipment is amply sized to make provision for growth. The institution is laid out to permit an ultimate capacity of 3,000 prisoners.

Some idea of the size of the institution can be gained by noting that the space within the enclosure, which is nearly square in outline, measures approximately 1800 ft. x 2000 ft.

Further evidence is shown by the estimates of steam requirements which are shown in Table 1.

TABLE I
STEAM REQUIREMENTS

Heating (present)	58,235	lb. per hr.
Hot water supply (present)	24,802	" " "
High pressure (present, for laundry, etc.)	3,960	" " "
subtotal	86,997	" " "
Heating (future)	17,530	" " "
Hot water supply (future)	11,650	" " "
High pressure (future)	1,320	" " "
Total	107,497	" " "

The cost of the heating and ventilating work is $550,000 while the power project will cost $337,000.

Power House and Power Apparatus

The institution is planned to be complete in itself and to furnish its own facilities as far as possible. In line with this idea both the power and the steam needed for hot water supply and incidental services are generated on the premises.

The power-house itself is an L-shaped building located near the dock. Boiler equipment consists of four vertical, water tube boilers each developing 500 boiler hp. at 200% rating. The boilers are built for a working pressure of 200 lb. per sq. in. and are equipped with automatically controlled underfeed stokers.

The boilers furnish steam to three reciprocating 28 in. x 32 in. Corliss engines which drive electric generators rated at 550 kw. each and deliver current at 480 volts, 3 phase, 60 cycle. The whole plant is operated non-condensing, the engines exhausting into a header under 12 lb. back pressure.

Boiler room accessory equipment is rather complete, including automatic control of the stokers, mechanical handling of the coal and ash, a periscopic smoke detector, and combustion control equipment. In addition, one open, vertical feedwater heater of the deaerating type is included, with a capacity sufficient to heat 105,000 lb. of water per hour when furnished with 12 lb. steam.

The engine room accommodates a 1500 g.p.m. fire pump, condensate pumps, a surge tank and two centrifugal boiler feed pumps. The plant also contains an adequate complement of gauges and meters placed on a meter board in accordance with current practice.

Steam Distribution and Return

Since the engines operate non-condensing the exhaust steam is available for building heating and for hot water heating. The general plan is to make use of the steam for these purposes, returning as much of the condensate as possible to the power plant where it is used for boiler feedwater. As considerable amounts of steam at higher temperatures than can be obtained with 12 lb. steam are used in several places for food preparation, laundries, and sterilization purposes, this steam is supplied from the boilers through high pressure lines. Since the exhaust steam available depends

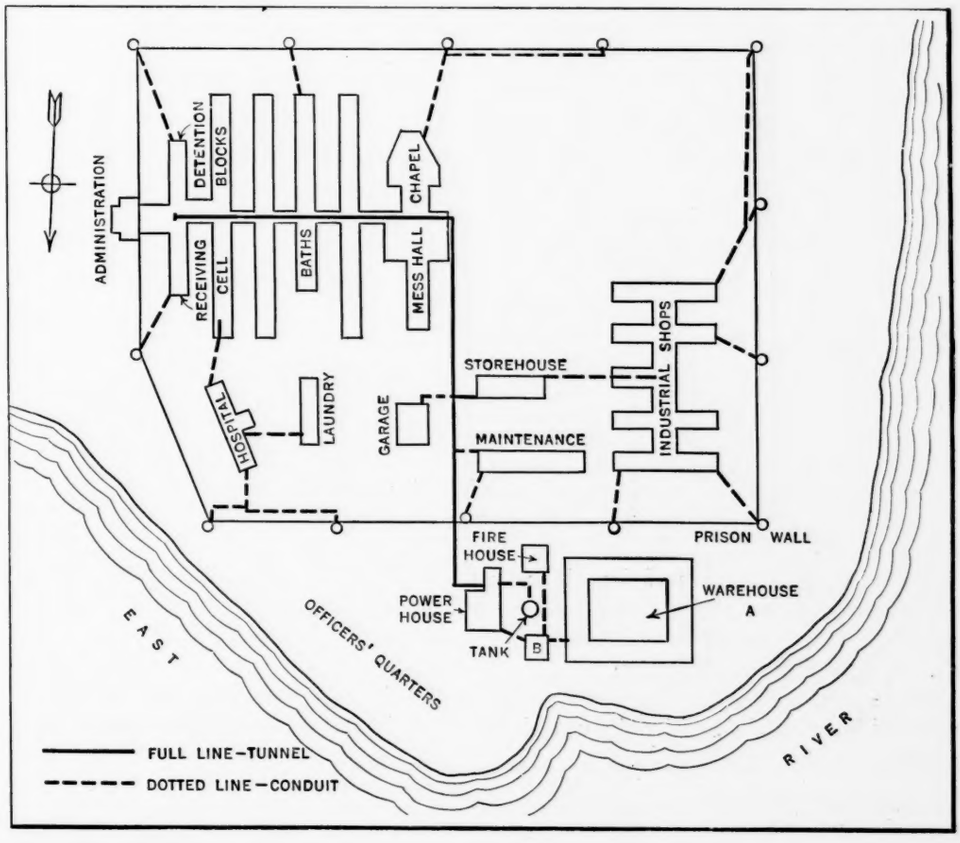


Fig. 2. Ground plan of the prison

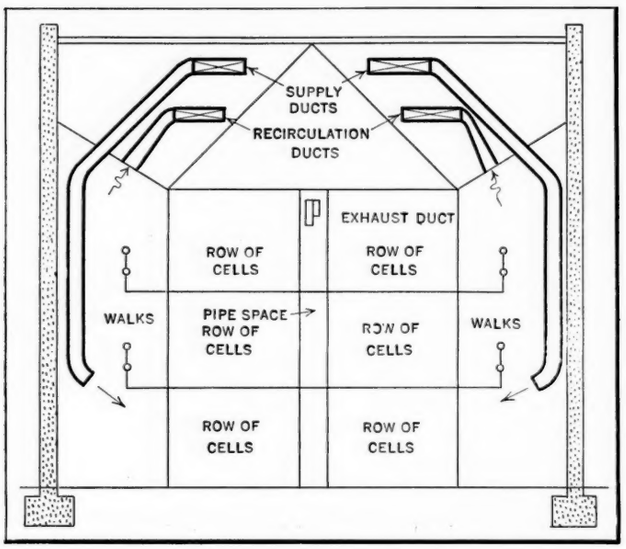


Fig. 3. Cross-section of Detention Building

upon the engine loads it is necessary to provide for make-up in times of deficiency. This is done by passing steam from the boiler header through a reducing valve into the exhaust heating line. At times when the engine exhaust exceeds the building heating requirements, exhaust steam is diverted to the feedwater heater and any excess is discharged to the atmosphere. This distribution of steam is accomplished by automatic valves operating on pressure changes.

Since a number of steam supply lines are necessary to supply the steam requirements of the buildings and since the topography made the construction of a pipe tunnel feasible, this method of distribution was adopted. In Fig. 2 the solid line shows the pipe tunnel and the dotted lines show steam pipes carried in conduit underground. The tunnel is 5 ft. 6 in. wide and varies in height from 7 ft. 6 in. to 12 ft. 6 in. as necessary to accommodate the piping details such as branches and crosses. Pipes are supported by means of rods extending from one channel to another, the channel beams being vertical and extending from top to bottom of the tunnel. The pipes rest on rollers which permit of movement due to temperature changes and the supports are spaced every 10 ft.

The 12 lb. heating main extends the full length of the tunnel, a distance of nearly 2500 ft. Branches are taken off as necessary to supply the buildings. Those buildings directly on the tunnel have equipment rooms to accommodate pressure reducing valves, hot water heaters and such apparatus. Buildings that are not directly on the tunnel are connected to others by conduits. The steam carrying lines are separately dripped into a low pressure drip line. The steam heating main is sloped in the direction of flow, being graded 1 in. in 30. On account of the long run it is necessary to step the main up at intervals, and when such a step occurs the main is dripped and trapped.

Expansion of the piping is provided for by loops where space permits and by the use of expansion joints on other occasions.

Each building is equipped with its own pressure reducing valve to step the pressure down from that in the heating main to 1 lb. per sq. in. at the discharge from the valve.

Vacuum heating is used in the buildings. Instead of each separate building being equipped with its own vacuum pump, the return lines from a group of buildings are brought together at a common point where a vacuum pump is located in a suitable equipment room. In this way one pump takes care of several buildings. The vacuum pumps discharge the condensate to return lines which feed into the surge tank at the power plant. Boiler feed pumps deliver the condensate back into the boilers. Make-up water is added in the surge tank which is equipped with gauge glasses and make-up water feed valves.

Condensate from high pressure utilization apparatus is carried back to the surge tank through separate return pipes.

Steam Heating Methods

A number of the buildings use direct radiators for heating with supply and return mains in the usual fashion. Some of the buildings, however, require special treatment because of the nature of the building and because of the uses to which they are put.

Among the unusual cases is that of the detention building. This consists essentially of one building inside another as the interior structure is made up of steel cells quite independent of the masonry building that surrounds them. Fig. 3 shows a cross-sectional view of this building. It is one-story high and accommodates three tiers of cells extending the whole length. At one end a space is provided for an isolation cell and visitors' room. These rooms are heated by unit heaters. The rest of the building is heated by a hot blast system.

Decision to use such a method was arrived at by consideration of a number of factors. While the occu-

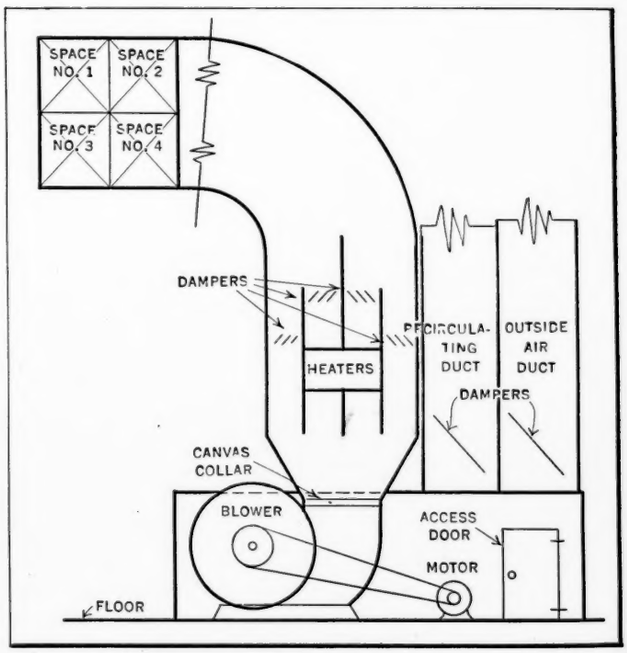


Fig. 4. Typical set-up of blowers showing method of by-passing and recirculating in prisoners-visitors section of Detention Building

pancy of the building is not dense—240 occupants being provided for—still it was necessary that an air supply be available. It is undesirable to install direct radiators inside the cell tiers in buildings of this character as they are likely to be tampered with by prisoners. Locating them outside the cell block, along the wall, is not considered a suitable arrangement as provision would still have to be made for air supply. Hot blast was chosen as a means of accomplishing the desired object of keeping the cell block free of the heating apparatus and at the same time providing for air supply from the outside. This method not only seemed to be suitable but at the same time is economical in first cost. Use of recirculating dampers makes it possible to take advantage of circulation during periods when there is no occupancy or when occupancy is small.

The fresh and recirculated air is mixed on the inlet side of filters and then passed through the filters and over heaters to the fan and ducts. The main duct divides into four trunk ducts running the length of the building, two on each side of the top of the cell structure. Branches are run down from these trunks on either side of each column. Forty such branches are located on each side of the cell block.

At each end of the building exhaust recirculating outlets are located over the cells in the ceiling. These recirculating ducts are united into one duct which is connected to the inlet side of the filter.

The importance of taking advantage of recirculation is evident when it is considered that the buildings are virtually empty twelve hours a day when prisoners are eating and working in the shops.

The administration building in addition to accommodating offices also contains a visitors' section. A hot blast installation is also used for heating this room, which is about 100 ft. in length. The room contains steel cages placed back to back so arranged that the prisoner sits in one cage while the visitor sits in the other.

Fig. 4 shows the arrangement at the fan. It is installed in the basement in a specially constructed fan room. The fan being of the top discharge type, heaters are placed directly above the outlet and the ducts are widened on each side of the heaters to permit the installation of by-pass ducts. Thermostatically controlled dampers are located in both the heater and by-pass ducts.

The chapel, which contains two large auditoriums, is heated by thermostatically controlled unit heaters. Gravity exhaust is provided through the ceiling.

The mess hall required special treatment both because of the fact that it is occupied only a few hours of the day and also because of the kitchens. The kitchens are provided with separate exhaust systems while the dining rooms use a hot blast arrangement for recirculating. The system is thermostatically controlled.

The hospital is heated by direct radiators but requires high pressure steam for instrument, utensil, and bed pan sterilization, water stills and water sterilizers. Steam for this service is furnished at 40 lb. to 60 lb. Vapor vents through the roofs are included. The building is served by a 100 lb. steam line which permits of reducing the pressure as required in the various pieces of apparatus throughout the building.

The laundry is a large user of high pressure steam for washers, ironers and miscellaneous apparatus. Steam for this purpose is brought to it through an extension of the high pressure line serving the hospital. The building itself is heated by a combination of direct radiators and unit heaters. Hood exhausts are provided over the individual pieces of apparatus.

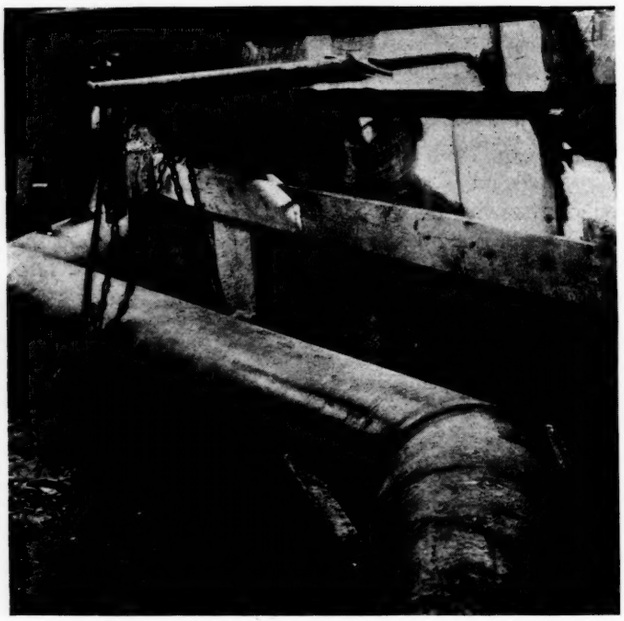
Included in the heating contract are four refrigeration plants located in four different buildings. Separate systems were installed because of the difference in the needs of the buildings. The hospital, for example, will operate its plant 24 hr. per day, while the mess hall system will only be needed four or five hours per day, etc. These plants are used for both cold storage and ice-making. The compressors are electrically driven and CO_2 is used as the refrigerant. Calcium brine is circulated by pumps through cooling coils located in the refrigerator boxes.

Sloan & Robertson were the architects. The heating and ventilating engineering was done by Clark, MacMullen and Riley.

Ewing Galloway

Arc Welded Construction Helps I

Arc welded piping has been found to have a tensile strength of over 60,000 lb., the result being that strong and desirable welds are obtained. From a contracting point of view the use of arc welding also results in economy and utility in the field.



THE major factor in the spread of district heating is the assurance of uninterrupted service to the customer. Not only are maintenance operations on underground pipe lines inconvenient, but they are costly as well. Every precaution which helps to insure the permanence and durability of the distribution piping is fully justified, both because of continuity of service and because of lowered maintenance costs and increased savings. Welded construction of distribution piping has come to be widely used.

High pressure steam lines must have a high fatigue limit and the ability to withstand varying temperatures, sudden shocks and pounds, as well as being resistant to corrosion.

We have used welded construction for some time and have recently used the shielded arc process of arc welding in some of our installations. Tests show that welds made by this process have high ductility and a tensile strength of 60,000 lb. to 75,000 lb. per sq. in. Its sponsors also claim that welds made by this process are highly resistant to corrosion. All these properties are desirable in steam distribution piping.

Our present welding technique in fabricating pipe is to run a butt weld at the joint and reinforce this with a second stiffening weld. Thus, the pipe is about 25% thicker at the joint and as this extra metal has the same qualities as the pipe metal, the strength of the joint is obviously greater than the strength of the pipe.

The contractor is concerned not only with the fact that strong and desirable welds result from the use of the arc process but he is also interested in economy and utility in the field.

An example of the use of electric welding on district heating lines is the five miles of underground piping recently completed for the Ohio Edison Company, at Akron. This system is designed to handle pressures up to 400 lb. and temperatures as high as 500°. Not

Photos courtesy Lincoln Electric Co.

Fig. 1. (Above) An obsolete fire cistern necessitated this bend in the main. The braces shown at the joint are to prevent the pipe from buckling.

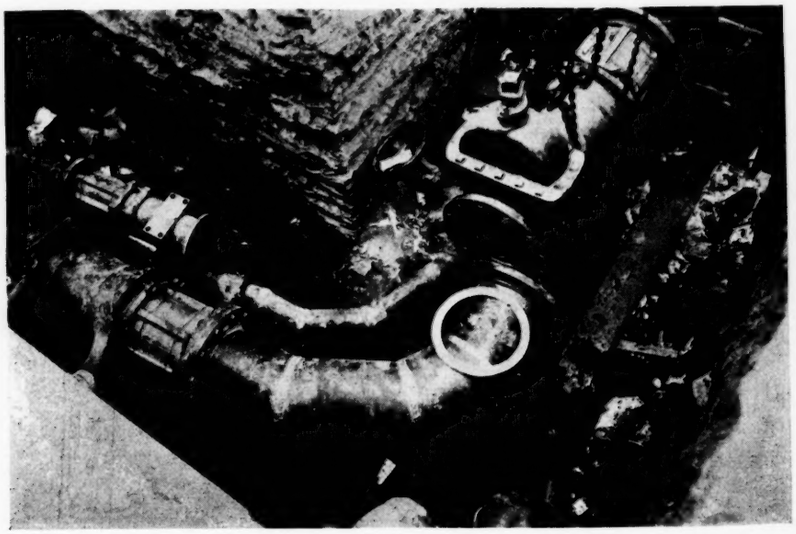
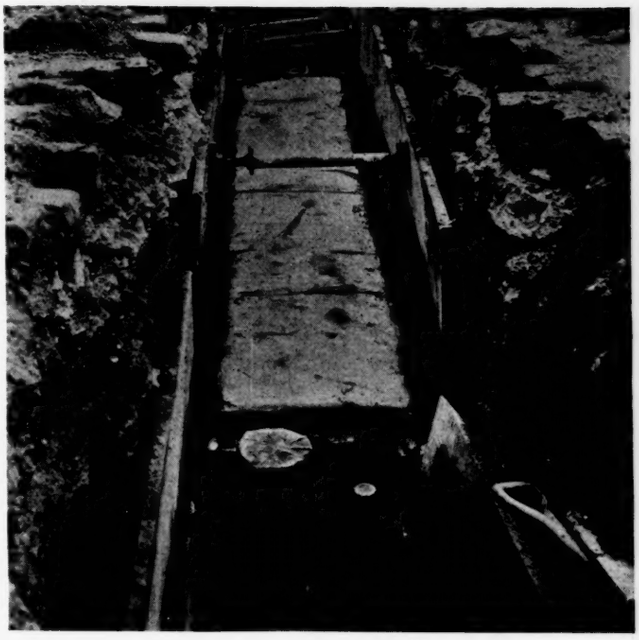


Fig. 2. (Right) Installation of slip type expansion joints on steam line and return. The welded bend was constructed on the job.

Insure District Heating Service

By E. R. BENEDICT†



only was the pipe itself welded but all take-offs, reducing joints, fittings, and, in fact, everything but the expansion joints were arc welded. Fig. 2 shows the installation of slip type Van Stone joints. The flange which connects the line to the joint is welded to the pipe wherever the insertion of an expansion joint is required. The bend, formed of mitered sections of straight pipe, was in this case an emergency matter, being electric arc fabricated on the job to avoid the delay of ordering a special tube bend.

Fig. 1 shows the ease with which the welding process enabled the steam line to be constructed past a disused and obsolete fire cistern. The structural braces which can be seen welded on each side of the joint in the foreground are necessary to prevent the pipe from buckling.

Service take-offs can be "fish-mouthed" and arc welded to the line to eliminate the use of fittings. Fig. 3 shows such take-offs on the steam and return lines capped for future use. Installation of such take-offs simplifies the problem met when greater demands are made upon the service.

Use of arc welding in district heating construction is not confined to the pipe itself. The same economies in time and cost, and the same ingenuity of design are possible in the erection of tunnel structures and heating plant equipment. Fig. 4 shows the structural steel in a pipe tunnel built for the Rochester Gas and Electric Company. High pressure pipe guides, pipe rollers, saddles and tunnel supports were welded.

In heating plants arc welding is also extensively used and these uses are widely accepted. The addition of new distribution lines by a central station often necessitates remodelling of the station equipment. In such cases the use of welding is advantageous in adapting the station piping to fit last-minute changes in design, and construction can proceed without delay.

† President, United District Heating, Inc., Cleveland, Ohio.

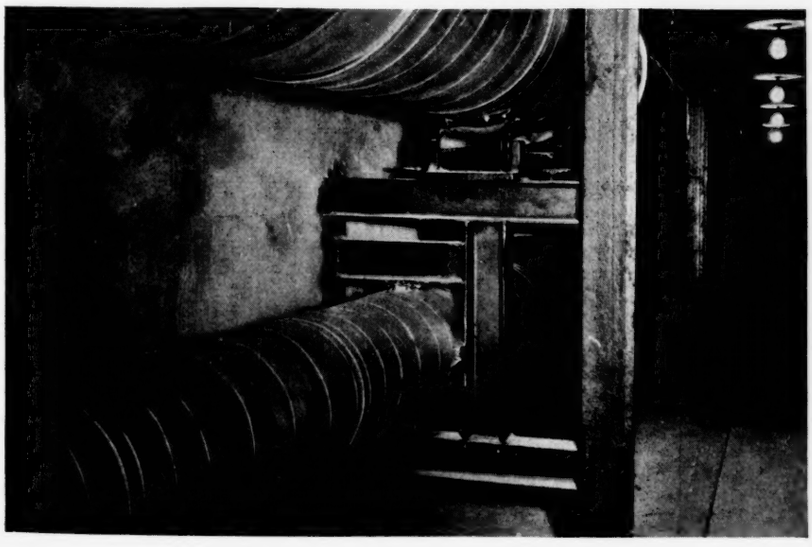


Fig. 3. (Above) Service take-offs on the steam line and return capped for future use.

Fig. 4. (Left) Arc welded construction of pipe supports, guides and rollers in a pipe tunnel.

Heating with Refrigerating Machines and Diesel Engines

By P. A. WILLIS†

A contributor in the November issue pointed out that with electrically-driven apparatus the reversed refrigeration cycle might not be so attractive as it first seemed. Professor Willis suggests that use of diesel engines in this connection might be desirable for heating in winter and cooling in summer.

DURING the past year or two, heating and ventilating engineers have been giving some little attention to the possibilities of the refrigerating machine as a device for building heating. The process involves the removal of heat from the outside air by the evaporating or cooling coil and the utilization of the heat given up at the condenser for heating purposes. The idea is not a new one, first having been proposed by Lord Kelvin, in 1852.

This method of heating becomes particularly attractive where refrigerating equipment is installed for building cooling in summer, as the same apparatus, with merely some additional piping and heating coils, may also be used to furnish heat during the winter months. In a recent article,[1] W. M. Benjamin makes an analysis of the possible performance of a refrigerating machine for heating a small house having an assumed heat loss of 60,000 B.t.u. per hr. With an outside air temperature of +10° and a warm air temperature of 80°, he obtains a net coefficient of performance of 2.42. This is based on motor-driven epuipment and an allowance for the heat liberated due to mechanical and electrical losses. With electricity at one cent per kilowatt-hour, he finds that heating by this method is equivalent to paying $15.60 per ton for coal. As the estimated cost of the equipment is $4900, the scheme does not appear very attractive. It might in some cases be cheaper than heating directly by electricity, but ordinarily could not compare with coal fuel.

Something that has apparently been overlooked by most investigators of reversed refrigeration is the advantage a heat engine may have over the electric motor as a source of power. Our modern heat engines reject from two-thirds to four-fifths of the heat supplied to them as fuel. Why not, then, drive our reversed refrigerating machine, or heat pump, with a heat engine, utilizing not only the heat delivered by the heat pump, but in addition, the heat rejected by the engine and usually wasted?

In many sections of the country the diesel engine competes favorably with central station power, even in fairly small units. Its application becomes considerably more attractive when used for driving a heat pump, since about 80% of the heat rejected by the engine through the jacket water and the exhaust gas becomes available as additional heat that could not have been supplied by an electric motor.

The average diesel engine of moderate size has a heat balance about as follows:

Heat converted to useful work	30%
Losses to friction, radiation and auxiliary power	15
Loss to jacket water	30
Loss to exhaust gas	25
	100%

Except for a small radiation loss, all of the heat passing to the jacket water is available for use in the heating system. If the engine is placed inside the building the radiation loss need not be considered. The amount of heat that can be recovered from the engine exhaust depends upon the exhaust gas temperature, but a reasonable value should be about 60%.

Assuming a net coefficient of performance of 2.5 for the refrigerating apparatus, the following values then result:

Heat supplied by heat pump, 30% x 2.5	75%
Heat from jacket water	30
Heat from exhaust, 25% x 0.60	15
Total heat delivered expressed in percent of heat supplied in engine fuel	120%

In other words, for each 100 B.t.u. supplied in the engine fuel, 120 B.t.u. is delivered for heating. If the same fuel oil were burned under a heating boiler with an efficiency of 70% the heat delivered would be $\frac{70}{120}$ or 58.3% of the heat made available by the diesel engine and refrigerating machine. With No. 4 oil costing three cents per gallon and having a heat value of 18,000 B.t.u. per lb., the fuel cost with the engine-driven heat pump is 1.85 cents per 100,00 B.t.u. This is equivalent to $3.37 per ton for 13,000 B.t.u. coal burned under a heating boiler with an efficiency of 70%.

With motor-driven apparatus and the same coefficient of performance as above, the power consumption per 100,000 B.t.u. would be $\frac{100{,}000}{2.5 \times 3412}$ or 11.72 kw-hr. At one cent per kilowatt-hour the equivalent cost of the same coal as before becomes $21.33 per ton.

The apparatus required for heat recovery from the diesel engine need not be complicated nor costly. A

† Associate Professor of Mechanical Engineering, Missouri School of Mines.

[1] A Discussion of Reversed Refrigeration, HEATING AND VENTILATING, November, 1931.

series arrangement of the heat transfer units would probably be best. In order to keep the head pressure of the refrigerating machine as low as possible, the heat should be picked up first from the ammonia condenser, then from the exhaust gas heater, and lastly from the engine water jacket. Assuming that the water entered the condenser at 70° and left at 90°, the rise in temperature through the exhaust gas heater would be $\frac{20 \times 1.20 \times 0.15}{0.75}$ or 4.8°. The rise through the engine jacket, neglecting radiation, would be twice that amount or 9.6°, giving a total temperature rise of 34.4° and a water temperature available for heating of about 104°.

This would probably be too low a jacket water temperature for best operation of the engine. In that case, a heat exchanger could be used with a closed circuit through the heat exchanger and the engine jacket. This system is now used in many diesel installations to prevent liming of the jacket, soft water being used in the jacket circuit.

The exhaust gas heater could be similar to a steam power plant economizer, and the conditions of operation would be about the same except for a higher rate of water flow through the exhaust gas heater and a smaller temperature rise. If the forced warm-air system of heating is used it might be more efficient to transfer the heat directly from the exhaust gases to the air. In this case an air heater similar to the combustion air preheaters used in steam plants could be connected into the duct system, precautions of course being taken against leakage of the exhaust gas into the air.

The diesel engine is not available in small enough units to use in connection with a heat pump for individual residence heating. However, it is very doubtful if a heat pump unit can be developed that will compete economically with our present methods of residence heating, due mainly to the initial cost of equipment.

In the larger buildings it would seem that refrigerating apparatus driven by diesel engines might provide a desirable method of heating in winter as well as cooling and air conditioning in summer. The effectiveness of this method would be relatively greater in mild climates where the temperature in winter seldom goes below freezing, but where building heating is nevertheless required over a considerable portion of the winter season. In any case, the use of the same equipment for cooling in summer and for heating in winter is an attractive possibility and one worthy of consideration in connection with the design of any large building.

Ventilating Chicago's New Post Office†

THE nature of the work done in this building is such that it was impossible to construct light and ventilating shafts in the interior of the area; therefore, the only natural light and air are from windows in the exterior walls. This condition required the installation of an extensive mechanical ventilating system. For the general ventilation of the building, there is supplied each minute 1,188,000 cu. ft. of fresh air delivered to the building by 55 fans. For the general ventilation of the building, there is exhausted each minute 1,092,000 cu. ft. of air, to which must be added 431,000 cu. ft. exhausting the poisonous gases from the mail trucks and 360,000 cu. ft. carrying the smoke from the locomotives on the tracks below the building; this is accomplished by the use of 75 exhaust fans.

If the quantities of air handled are reduced to weight, there will be supplied 96,000 lb., equivalent to 48 tons, of fresh air per minute, while the total exhausted will be 152,000 lb., or 76 tons, per minute.

The quantity of air supplied in a day of 18 hr. is equivalent to a layer six feet high and eight square miles in area, while that exhausted is more than 50% greater than this.

To carry away the smoke and fumes from the locomotives there has been provided an open channel above the center of each track communicating directly with a smoke chamber which covers the entire area of the building, occupying a space between the air rights level and the first floor. This is connected to eight shafts distributed as nearly equally as possible, which are carried up through the building. Exhaust fans, which are started and stopped automatically as trains approach the building, draw air from these shafts and discharge it above the roof.

Constructing the building above the railroad tracks made it impossible to install steam or other piping below the first story, where it would be out-of-doors or subjected to corrosion from smoke.

To avoid this the first and second stories are equipped with a hot water system having forced water circulation. The remainder of the building is heated by steam. There is a total capacity in direct radiation of 49,000 sq. ft. of hot water and 138,000 sq. ft. of steam. The heaters which are used to heat the air supplied by the fresh air fans have a capacity of 12,250 sq. ft. of water and 90,000 sq. ft. of steam radiation.

The installation of temperature indicating instruments has made it possible to ascertain at any time at a central point in the building the temperatures in each story, readings being taken at five points in the story. In this way the chief engineer or custodian can always tell what the system is doing and make such changes and adjustments as are required from time to time to maintain comfortable conditions.

† Abstract from "The Chicago Post Office," a paper by Alfred Shaw, architect, and M. G. Gunderson, chief structural engineer, of Graham, Anderson, Probst & White, architects, before the Western Society of Engineers.

Air Conditioning

By WILLIAM HULL STANGLE

Part XV—Mechanical Refrigeration (Continued)

By R. W. WATERFILL

Power Requirements

It is generally understood that the power required to produce a ton of refrigerating effect increases as the temperature of the low side corresponding to the back pressure is reduced. The trend and relative changes can best be obtained from the Carnot cycle. For example, if we produce a ton of refrigerating effect on the Carnot cycle with the absolute temperature T_1 equal to 490° and the temperature of condensation equal to 550°, the theoretical power required by the Carnot cycle is

$$\frac{550-490}{490} \times 200 = 0.122 \times 200$$

= 24.5 B.t.u. per min. or 0.58 h.p., where 200 equals B.t.u. per min. equivalent of one ton of refrigeration. With a fluid which is 85% as efficient as the Carnot, power requirements per ton would be 0.68 h.p. When we increase this 50% to obtain the actual compressor power required, we obtain 1.02 hp. per ton at these conditions.

If we produce the ton of refrigerating effect at a temperature of 5° or 465° absolute, and maintain 550° absolute in the condenser, we obtain a ratio

$$\frac{T_2-T_1}{T_1} = \frac{550-465}{465} \times 200$$

= 0.182 × 200 = 36.4 B.t.u. per min. per ton.

The corresponding ratio under the previous condition equals 0.122. Since these ratios are the ratios of the work areas ABCDA for the two conditions for the same amount of refrigerating effect, they represent approximately the ratio of the power requirements for the two conditions. Thus, if we have a working fluid which does not undergo any appreciable change in efficiency over the ranges considered we find that the second condition would require

$$\frac{0.182}{0.122} \times 1.02 = 1.52 \text{ hp. per ton.}$$

For ammonia the back pressures corresponding to 30° and 5° respectively are 59.74 lb. and 34.28 lb. absolute. The total reduction is approximately 25 lb. with an increase in power per ton of 50%. This relation of power requirements, however, would not hold for any other pressure range. Similar results would be obtained by increasing the condenser temperature T_2 and maintaining a constant back pressure.

The ideal operation of a refrigerating plant would be to maintain the highest evaporating temperature of the refrigerant, or back pressure, permitted by the particular duty to be performed. Since, however, most, refrigeration tonnage loads vary, the refrigerating system should be flexible enough to absorb these variations without appreciable reduction in back pressure. The usual cause of back pressure fluctuation is a constant compressor displacement and a variable weight of refrigerant vapor or B.t.u. to be pumped.

In addition to the high back pressure, a low head pressure is essential. The head pressure, however, is generally subject to seasonal variations, following the temperatures of the condenser water. The efficiency of operation of the high side is measured by the spread between the temperature, corresponding to the head pressure, and the temperature of the condenser cooling medium. For the ideal system performing a fixed duty, therefore, the back pressure is approximately constant and the head pressure varies in a definite manner. The head pressure or temperature to which the heat must be elevated for disposal as above indicated is governed by the temperature of the available water supply, the quantity consumed, and by the efficiency of the condenser. Some small units are cooled by surrounding air instead of water. In this case the head pressure is governed by the temperature of the air, its movement and the efficiency of the condenser. In most instances, however, we can treat the subject from the standpoint of the water-cooled condenser.

Condensing Apparatus

The types of condensers in general use are the horizontal shell-and-tube, the vertical open end shell-and-tube, the single pipe atmospheric condenser, and the double pipe condenser. One modification of the horizontal shell-and-tube condenser is the multiple shell-and-tube, used particularly with high pressure refrigerants such as carbon dioxide.

The efficiency of the condenser depends upon the square feet of surface per ton, the velocity of the cooling water through the tubes, the circulation of the refrigerant vapors around the tubes, and the concentration and elevation of non-condensable gases from the system. Continuous automatic purging of the non-condensable gases is essential to high maintained operating efficiency in all except totally sealed units. The presence of these gases not only increases the head pressure against which the compressor must operate by the amount of the partial pressure of such gases existing

in the condenser, but also these gases reduce the effective rate of heat transfer of the refrigerant vapors, thereby further increasing the head pressure.

Amount of Condensing Water

The quantity of condenser water which should be used depends upon the economical balance of the cost of water and of power for the refrigerant compressor. It is evident that the minimum power requirements of the compressor would be attained by using an infinite quantity of condenser water with 0° rise. In other words, the water would be absorbing the heat without change of temperature, thus leaving at the same temperature as entering. This is an extreme condition. If we use a small quantity of condenser water so that its temperature rise is great, the compressor power will increase rapidly. Fig. 1 shows the hyperbolic relation between condenser water consumption in g.p.m. per ton, and approximate increment of increase in actual indicated compressor horsepower. In other words the increment is the additional power for each degree temperature rise above the entering water temperature. This figure demonstrates the poor economies of water rates less then 1 g.p.m. or more than 5 g.p.m. per ton of refrigerating effect. Sometimes, however, a water shortage necessitates reduced consumption. It is quite clear that economical practice should lie somewhere between these limits because of the rapid increase of either power or water consumption with correspondingly little saving beyond either of these limits in the other factor of the economic balance.

There are two primary methods of procuring cooling water for condenser purposes. One of these is direct purchase and the other is pumping from a cooling tower or some other source—as a well, river, etc. Where water is purchased it is found that for all refrigerating cycles of approximately the same efficiency as the ammonia cycle the economical consumption of water varies from approximately 1 to 2 g.p.m. per ton. Where water is pumped from a cooling tower or other reservoir the economical circulation is somewhat dependent on the pumping head required for the water. This ranges generally from 3 to 4 g.p.m. per ton.

An equation for determining the combined cost of water and power when the water is purchased is:

$$C = \frac{W_c}{E_1} A + \frac{H_c}{8.33\, t_d} \times 0.06B, \text{ where}$$

W_c = Compressor i.hp. per ton
$E_1 = E_c \times E_d$
E_c = Mechanical efficiency of compressor
E_d = Efficiency of driving unit
A = Cost of power per horsepower hour input
H_c = Heat to be removed in condenser per minute per ton

$$= 200 \times 42.4 \times \frac{W_c}{E_1}$$

B = Cost of cooling water for the condenser per 1000 gal.
t_d = Rise of temperature of cooling water

Where water is pumped and the cost of power for pumping is at the same rate as for driving the refrigerant compressor, the total operating cost can be determined by an expression inter-relating the horsepower of the compressor and that of the circulating water pump. Probably a simpler method is to reduce the cost of pumping to a definite value per 1000 gal. and use the same expression in determining the total costs as for purchased water. Charts simplify greatly the proper selection of the most economical consumption of water in the design of a refrigerating plant. After the plant has been installed, the combined costs are easily ascertainable, and by the calculation of costs with increased and reduced circulation it can be determined whether the minimum total operating cost is being obtained.

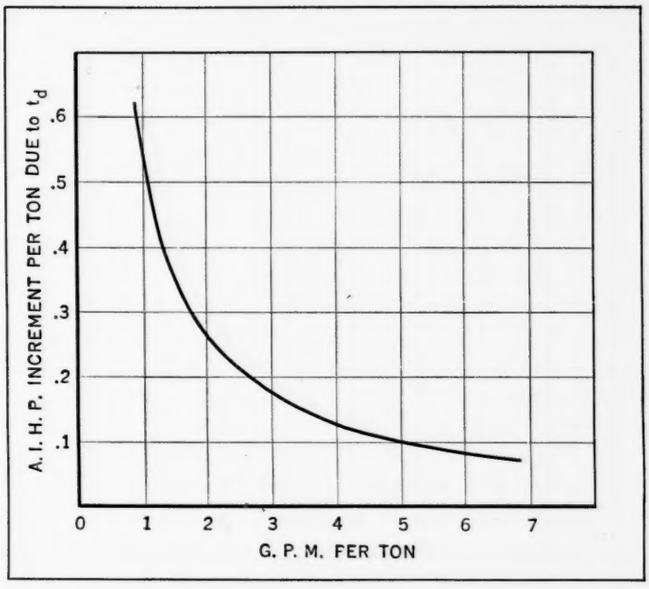


Fig. 1. Relation between condenser water consumption and increment of increase in horsepower

Safety Considerations

Aside from operating efficiencies, which are a prime essential of the industrial refrigerating system, the ever-widening application of refrigeration is bringing to the fore other desirable qualities such as safety, compactness and simplicity.

Intimate association of air conditioning applications, domestic refrigerators and even some industrial systems, with the public has made safety the dominant requisite in many cases. Indeed, it is only through safe systems, safely installed, that public confidence in refrigeration is deserved. Creditable performance will result in a wider use of refrigeration, resulting in higher living standards, better health and greater enjoyment of life.

The selection of the machinery best suited to the service to be performed can be made only by a careful analysis of all the factors involved. Some of these considerations, which must be weighed and balanced against others, are safety, low first cost, low operating cost, low maintenance, simplicity, space requirements, and flexibility of the equipment. The duty to be performed may itself be variable with high peaks and a low load factor. It may also be in service 24 hr. per day or only intermittently, often not exceeding 3 hr.

out of every 24, with possibly an operating season of only 100 days or less. All of these factors, and many others, need be considered in the selection of the type of equipment and refrigerant to be used. It is the proper function of the engineer designing the air conditioning system to analyze these factors.

The several cycles of operation and the refrigerants in use have already been discussed in a preceding article. The machinery must be adapted to the cycle and to the refrigerant. In general, too, each type of machine has a preferred field of operation. Thus, as a rule, centrifugal units are best adapted for fairly large sizes and low pressures, while positive piston machines find their best field in smaller capacities and high refrigerant pressures.

In the present state of development it would seem that centrifugal machines are commercially applicable only to the larger capacities, though recently capacities as low as 20 tons in a single unit have proven economical. For all smaller capacities, however, positive compression machines at present have inherent advantages in first cost and, to some extent, in operation. In the smaller capacities, centrifugal machines must either increase in speed or else operate at reduced efficiency. In the small positive compression machines an increase in speed is desirable and there is but little disadvantage in efficiency in the smaller sizes. There are many other considerations determining the type of compression to be employed, as, for example, whether a steam engine or steam turbine drive is preferred in steam-driven units. It is obvious that a centrifugal type of unit is not adapted for steam engine drive, and, conversely, positive compression is not so well adapted for steam turbine drive.

While the majority of refrigeration installations for air conditioning are of the compression type, there are still employed a number of ammonia absorption units. This is one of the oldest methods of refrigeration and has found favor where large quantities of waste heat in the form of low pressure steam are available.

Absorption systems, however, have been little used in air conditioning work as they are best adapted to low temperatures. Increased back pressures occurring in air conditioning work do not give the advantage in this type of equipment that they offer in the positive compression machines, and the cost of the absorption system in general is more than for compression systems. It is quite possible, however, that for small units the absorption system may find increased favor, as it has possibilities of automatic operation and freedom from moving parts that cannot be obtained in the compression system. It is particularly well adapted where low pressure steam is continually available, or where gas may be used as a fuel for operation.

In addition to the older type of ammonia absorption machines, there are two new types of absorption machines coming into use. One is the hydrogen-filled machine now in use only in gas-fired household refrigerating machines, and the other is an absorption machine using solid absorbents, such as silica gel. Both of these systems have possibilities for further development. It is quite possible that one or more of these systems will eventually be developed for the cooling and air conditioning of our homes in summer, and for other places where only relatively small quantities of refrigeration are required.

The piston compression machines are generally connected to baudelot coils or bunker coils on the low side, for air conditioning. The baudelot coil construction consists of a series of pipes made up to form a vertical coil or stand. Several of these stands are placed together to form a bank, the number of stands required depending on the capacity of the installation. These coils are placed in an insulated room with a water tank at the bottom. The water to be cooled is distributed by drip troughs, and runs down over the coils. The refrigerant is expanded or vaporized within the coils, thus absorbing the heat from the water flowing on the outside. The water, when cooled, is then pumped to a dehumidifier, through which the air to be cooled is passed. The water is then returned by gravity to the baudelot tank and recooled.

A more recent practice is to place direct expansion bunker coils in a dehumidifier in the air passage and spray water over the coils. The air passes through both the spray and the cool surface. This construction economizes on space, simplifies operation and improves the overall surface efficiency.

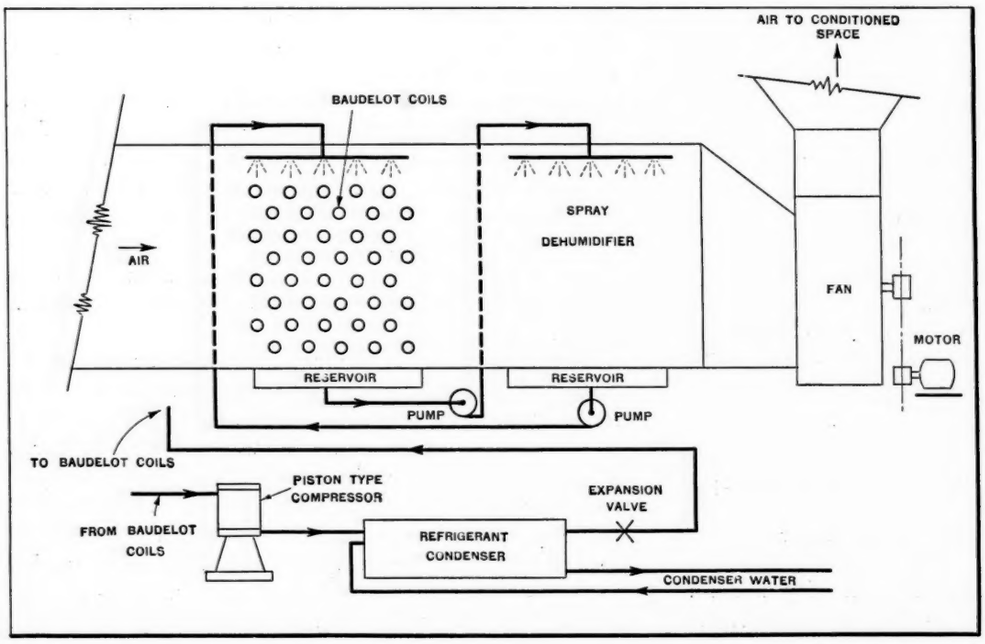


Fig. 2. Dehumidifying system with piston type compressor

Fig. 3. Dehumidifying system employing centrifugal compressor

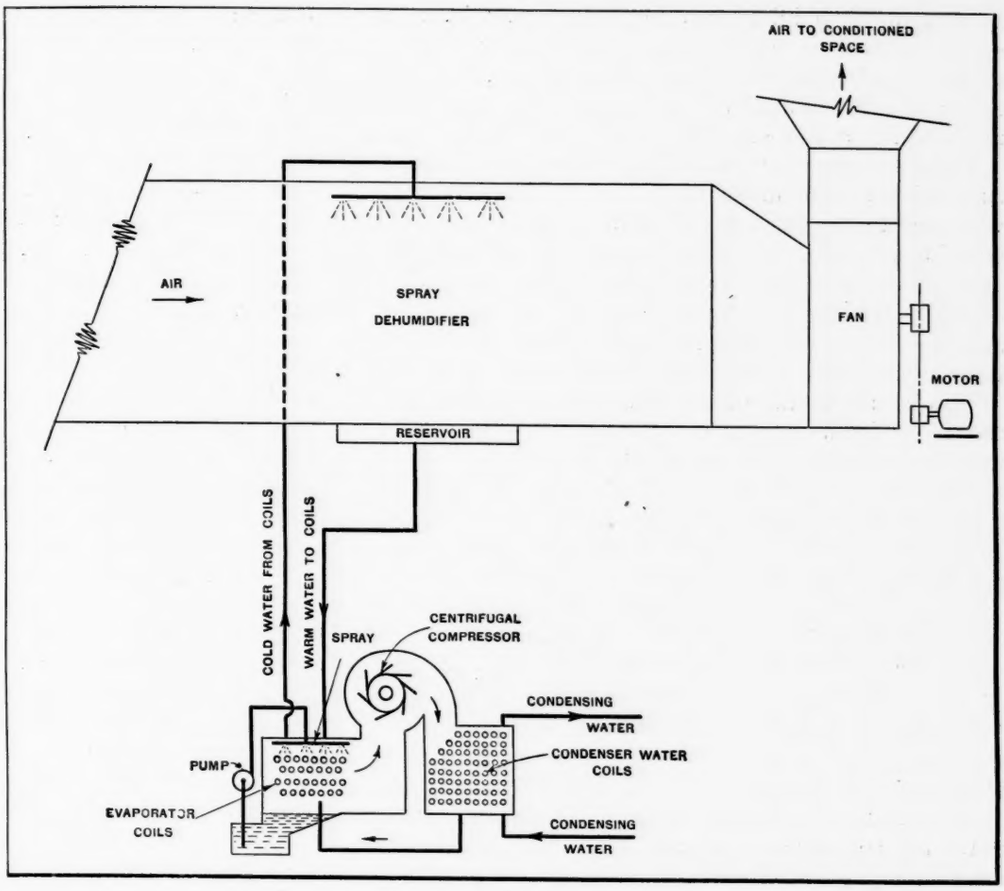


Fig. 2 shows a typical arrangement of a dehumidifying system employing a piston compression type refrigerating machine. In this instance, the water which is cooled by the direct expansion of the refrigerant in the baudelot cooler is sprayed into the air stream in the dehumidifier.

With the centrifugal compressor, the fresh spray water for the dehumidifier may be cooled directly in a shell and tube cooler without danger of water freezing within the tubes, for the reason that the centrifugal compressor tends to maintain a relatively constant temperature head just as the centrifugal pump tends to maintain a constant hydraulic head. The capacity of the compressor automatically adjusts itself to the load imposed and maintains a constant temperature of the cooled water.

The general construction of the centrifugal compressor is very much like the multi-stage centrifugal pump. Single compressors of one to six stages have become quite common. The rotational speeds of the smaller units are about 10,000 r.p.m., while the standard speeds for the larger capacities are 3500 r.p.m. Of course, the wheel diameters change so that the effective peripheral speeds are not greatly different. The peripheral speeds, rather than rotational speeds, determine the stresses. These are much less than common steam turbine practice.

Fig. 3 shows a typical spray type dehumidifying and distributing system employing the centrifugal compression type of refrigerating machine.

Advantages of Quantity Surveying‡

By CHARLES M. BETTZHOOVER†

QUANTITY surveying is generally taken to mean the providing of accurate lists of materials for all sorts of construction, roads, bridges and buildings. We are interested as far as this article is concerned with surveys for building construction. Some survey bureaus provide both lists of materials and the labor hours for their installation. Some bureaus are operated by contractors, others are privately owned or operated by those whose interest ends with the supplying of the quantities, to others, who carry on the contracts.

Bureaus operated by contractors do not have entree with architects and owners because of the fear of collusion in the submitting of bids. This is natural, although in many cases these bureaus are operated honestly.

The privately owned survey bureau has a decided advantage in being able to approach architects and owners in an impartial manner. You are not interested

‡ Abstracted from a paper presented before the American Institute of Quantity Surveyors.

† President, The Bettzhoover Electric Co., Cincinnati.

in securing a building contract, but in rendering a service. You can ask for and obtain interpretations of plans and specifications that will result in the preparation of one standard list of quantity and quality of material for all bidders alike.

When a contract is bid in a lump sum basis without supporting lists of materials and labor hours, there is very apt to be guessing, guessing at quantities and guessing at labor. Also some contractors, if they receive an award, expect to use cheaper materials, they expect to peddle bids around among sub-contractors and they expect to soak the owner on extras. Not all contractors follow these tactics, but some do.

This results in the owner getting cheaper construction for which he pays a pretty stiff price, although the price looked lower in the beginning. So the owner pays less and in turn gets less, and if he requires additional work or makes changes in the plans and specifications he is sure to get a high price on such changes, out of line with the price of the original contract.

On the other hand, if contracts were awarded on a quantity survey basis, with unit prices at which additional work would be billed, or omitted work credited, an ideal condition would exist.

The owner would get the materials specified, and the contractor would get a just price. And if the plans and specifications are later modified during the progress of the building, it is a simple matter to arrive at the fair cost for such changes, subject to adjustment for alterations to work already in place.

Buildings of today are complex in their appointments. Trained and technical men are required to plan and design them, and other trained men are required to take off the plans and make lists of materials. No contractor has enough volume of business to warrant the retaining of skilled estimators for the different branches that today enter into a building, on a full time basis, because the cost of maintaining and housing this staff would raise his overhead so high that he could not obtain contracts.

The ideal condition from an economic standpoint is the central estimating or survey bureau. To this bureau the architect sends a set of plans and specifications, skilled men iron out the ambiguities, and correct errors with the assistance of the architect. Then one correct listing of quantities and labor hours is provided. These lists are then furnished to the contractor customers of the bureau on a fee basis. No contractor, not invited by the architect should be permitted to bid on the project. The bureau must maintain a discreet silence regarding the number and names of the bidders.

The architect must do his share by confining his invitations to bidders to those who have the organization and capital to carry out the project, and above all no contractor should be expected to bid who will not receive the award if his bid is the lowest and best one.

Government reports reveal that 40% of the building contractors fail in the business.

Why this high mortality? The American people are a restless race, they are gamblers, and under present conditions the worst guessers. Generally, the poorest and least efficient contractors receive the contracts, the award of which marks the beginning of arguments between the architects, superintendent and the contractor regarding the scope and intent of the plans and specifications.

This condition could not exist under an accepted plan of quantity survey. Some contractors will fear that a list of materials and labor hours will enable other contractors who lack ability to prepare such lists themselves, to compete with them on work. But there is nothing that will take the place of efficiency and ability and the advantage is still with the better contractor. Suppose you give the poorest contractor a full and complete list of materials and labor hours, a list that he knew was just about as perfect as could be made, don't you think that with this authentic and concrete information your competition will be better than if he guesses at his estimates? I am sure you will agree with me on this, that the hit and miss bidder is going to be more in line with his figures if he is correctly informed than otherwise.

The question might also be raised about the correctness of the surveyors. It is reasonable to suppose that more errors will be made in the contractor's own office where interruptions are frequent, where his attention is divided between answering the insistent telephone and conversing with callers, than in the central bureau. It is surely apparent that the trained specialist in the survey bureau free from interruptions, devoting his time solely to surveys, will have the more accurate listing, will be able to do the work more thoroughly than the estimator who estimates a little, sells a little and supervises a little.

There is another point that I wish to touch upon. That is the position of the surety bonding companies. I have seen bonding companies hungry for business, ready to sign a bond for a contractor, whose source of supplies expect and receive cash on delivery. This is not a good practice. If the bonding companies would only sign bonds for contractors who use quantity surveys, their losses would be smaller and their rates could, therefore, be reduced, resulting in another saving to the owner.

In conclusion, whatever our field of action, we shall never succeed unless we realize that we are here to serve, that the taking of a contract is but the opportunity of being of service and that when we subscribe for the service of the quantity survey, we are in a position to give our customers the benefit of lower costs, more accurate estimates, assure him of fair dealing and just treatment. That the quantity survey will guarantee to the owner a just measure and avoid misunderstanding of the plans and specifications, is easily understood.

Above all, the test of worth is service. Serve yourself and no other and you are a failure. There is honor in using talent to accomplish your works.

No fair minded owner will want to take advantage of a contractor, or expect him to do business at a loss. The spirit of fair play will take care of this. The owner only wants value for his money and he is assured of this when a complete unit price survey listing accompanies the bid. Confidence is immediately established between owner, contractor and architect to the end that the architect's creation will be a building that all can be proud of and built at a reasonable price.

Abstracts . . .

Reviews and Summaries of . . . . Current Papers, Books and Pamphlets

A Survey of Research in Coal and Coal Utilization

A mimeographed pamphlet, 30 sheets 8½ in. x 11 in., including five pages devoted to a topical index. Unillustrated. Obtainable from Committee of Ten—Coal and Heating Industries, 1715 Bell Building, 307 N. Michigan Ave., Chicago, Ill. Price 25 cents.

A listing of research projects under way, as reported to the committee from various sources, and also a partial list of publications resulting from past studies. The method of presentation consists of an alphabetical listing by name of research agency, followed by a brief statement of nature and status of project, and by a list of publications. A feature of the listing is the inclusion of European work.

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School Ventilation Principles and Practices

Contribution No. 7 of the New York Commission on Ventilation, 73 pages, 5 in. x 7½ in., cloth, unillustrated. Obtainable through the Bureau of Publications, Teachers' College, Columbia University. Price, $1.

The preface states that the book is a brief final report of the commission, summarizing the whole situation as of June, 1931.

After reviewing the development of ventilation for schools and summarizing the state laws dealing with the subject, the story of the commission and its work is told. The results of the early schoolroom and laboratory tests are reprinted, followed by the story of the activities which have taken place since. About two-thirds of the pages are taken up by these later phases. Approximately four pages are devoted to the work at the Pittsburgh laboratory.

Under the head of Unsolved Problems of Ventilation, the following statement is made: "There are many unsolved problems of ventilation which still require elucidation. We have indications that temperature variations at various levels above the floor may have considerable physiological significance (Vernon and Bedford, 1930), but no conclusion can at present be formulated as to the desirability of exposing head or feet to temperatures lower than those affecting the body. We have learned that heat loss by radiation is of fundamental importance (Aldrich, 1928; Bloomfield, Ives, and Britten, 1930), and the English are making interesting experiments in radiant heating (Vernon and Vernon, 1928). Yet we are not in position to express any opinion as to the relative physiological effects of heat loss or heat absorption by radiation as compared with the effect of convection. There are possible effects of ionization and other physical properties of the atmosphere which would richly repay study."

The commission has long advocated changes in the legal regulation governing school ventilation. The discussion and proposal are thus presented in its final report:

"It would be obviously unwise to repeal present regulations without putting more reasonable ones in their place, since the absence of any provision for schoolroom ventilation has been shown to be associated with highly undesirable conditions. It is important, therefore, to consider the basis on which such regulations should be established.

"There are two general lines of approach to a problem of this kind. We may specify the hygienic results to be attained; or we may specify the engineering devices to be used in their attainment.

"The first of these methods of approach naturally appears to the hygienist as logical and reasonable. It is the end which is important; and any technique which will attain that end should be permissible. This line of thought would lead to a regulation specifying certain conditions of temperature with freedom from draft and with, perhaps, a liberal carbon dioxide standard. The engineer and the architect, however, are not unnaturally opposed to a regulation of this type since, if actually enforced, it would place upon them the entire onus of predicting the results to be obtained from a given system. They greatly prefer concrete specifications of apparatus to be provided, which they can meet with certainty.

"The alternative type of regulation, laying down the details of the structural elements to be provided, is, therefore, the one generally favored by the engineering profession. At the present time, committees of engineering bodies are at work on model codes framed along such lines and going into great detail in specifying the exact engineering methods which should be used in ventilating buildings of various types.

"There is very serious objection, however, to the crystallization in legal form of such minute and detailed specifications as would be necessary if this plan of procedure were to be effectively carried out. The art of ventilation changes from year to year. It is subject to wide variations in its application to different buildings. It differs in its application to the same buildings at the same time in the hands of equally competent engineering experts. If regulations of the type proposed are to be effective at all, they must be very precise and definite; but to enact into law the precise and definite details which happen to appeal to a particular group of experts at a given time would not only put a stop to progress in the future, but would create

a condition intolerable to the engineer who desires to approach his problems of today and of tomorrow with imagination and creative power.

"Fortunately, there is a third mode of approach to the problem of regulation which combines the advantages of the two so far discussed, without their graver disadvantages. This is the method which (a) specifies the general objectives to be attained and (b) confers upon a small expert group the power to determine whether a given design is reasonably adequate to attain those objectives. This is essentially the procedure involved in all modern legislation with regard to public health and industrial conditions, the principles only being embodied in the law and the details being subject to determination by a Board of Health or an Industrial Commission in the individual case.

"This procedure was suggested by us four years ago (Duffield, 1927) in an outline which our commission formulated as an answer to requests for suggestions as to a model ventilation law. With certain minor modifications, this standard form may be presented as follows:

GENERAL PROVISIONS

"1. After the passage of this act (adoption of this regulation) no school building shall be constructed, reconstructed, or enlarged, until plans and specifications for such construction, reconstruction, or enlargement, shall have been approved by (the legally constituted authority) and a certificate of such approval shall have been received by the local board of education, school trustees, or other body within whose jurisdiction the school is (or will be) located.

"All plans shall show, and specifications shall fully describe the systems of heating and ventilation it is proposed to install. Such heating and ventilating systems shall conform to the standard hereinafter provided.

HEATING AND VENTILATION

"1. Every school building hereafter constructed, reconstructed, or enlarged, shall be provided with a heating system of sufficient capacity to heat all parts of the building during the coldest weather, when adequately ventilated according to the following schedule:

a. Corridors, gymnasiums, and shops, 65°.
b. Swimming pools, and adjacent dressing-rooms 75°.
c. All other occupied rooms, 68°.

"Sources of direct radiation shall be so designed or protected as to prevent overheating of persons in seats adjacent thereto.

"2. All classrooms shall have at least 15 sq. ft. of floor space and 200 cu. ft. of air space per pupil and (including cloak rooms) shall be provided with a system of heating and ventilation including means of air supply and exhaust capable of avoiding unpleasant odors (such as are likely to accompany an increase of the carbon dioxide content of the air above 15 parts per 10,000) and of avoiding, without producing chilling drafts, an increase of room temperature above 68°.

"Such ventilation shall be accomplished (a) by mechanical means; or (b) by the window-gravity method (in rooms having 100 occupants or less); or (c) by any other method which will attain the results specified above.

"Special provision (preferably by mechanical means) shall be made for the ventilation of auditoriums, chemical laboratories, shops, cafeterias, and toilet rooms located in the buildings.[1]

"3. Every schoolroom used for instruction, study, assembly, and physical recreation, shall be provided with at least one thermometer of a grade that will give a reading accurate to within 1°. The thermometer should be so located as to give a representative reading of the temperature at the breathing plane of the pupils.

"4. Such an approved system of ventilation shall be maintained in operation whenever school is in session.

"Such a law would, as it seems to us, meet the essential needs of the situation. It lays down the essential objectives to be attained. It permits the engineer and the architect to present any design which, in their judgment, will attain these objectives. Finally, it requires that the State Board of Education, the State Board of Health, or such other official agency as may be designated, shall approve the plans as submitted. It is exactly in line with the procedure now followed with regard to water supply and waste disposal, and it appears to guarantee a maximum of protection for the public with a minimum of interference with freedom of initiative on the part of the designer.

After an eighteen-year existence, the commission arrives at six general conclusions.

"1. The major objective of schoolroom ventilation is the provision of such atmospheric conditions as will facilitate the elimination of heat from the body surface without the production of objectionable drafts. In practice, this means the maintenance of a room temperature of 68° to 70° with moderate air movement. Under such conditions, special control of humidity is not essential except, perhaps, in certain northern regions where humidity is exceedingly low in cold weather. A minor objective should be the provision of sufficient air change to avoid unpleasant body odors.

"2. The avoidance of overheating is of primary and fundamental importance for the promotion of comfort and efficiency and the maintenance of resistance against disease.

"3. Desirable conditions may be obtained by at least three methods of ventilation when proper design and operation is provided: (a) by plenum ventilation; (b) by local unit ventilation; (c) by window-gravity ventilation. For the average school, favorably located, window-gravity ventilation seems to be the method of choice on grounds of comfort and of economy.

"4. Further investigations, in regard to the physiological effects of radiation and convection of heat, of vertical variation in temperature, and of electrical and other properties of the atmosphere, are greatly to be desired.

"5. The present laws and regulations requiring a supply of 30 cu. ft. of air per pupil per min. in the schoolroom have no justification in theory, and, in practice, may involve a serious handicap to progress in the art of school ventilation.

[1] The report suggests as suitable quantities, amounts of air ranging from 20 to 30 cu. ft. per person per min., and from 2 to 12 cu. ft. per sq. ft. of floor, depending on the type of building.

"6. Such regulations should be replaced by laws outlining the major objectives of schoolroom ventilation and delegating to some small expert official body the power to determine whether specific plans for school ventilation are adequate to attain those objectives."

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Tests of Gas Home-Heating Equipment

By R. B. Leckie and C. H. B. Hotchkiss

Engineering Bulletin, Purdue University, Research Series No. 36; 166 pages, 6 in. by 9 in., illustrated. Obtainable through Director, Engineering Experiment Station, Purdue University, Lafayette, Ind. Price, $1.

Describes laboratory tests made with certain gas-designed and converted steam boilers of the size used for heating small homes.

The bulletin states that "the primary purpose of the tests was to secure data indicating the heat absorption efficiencies which could be obtained from some leading types of gas conversion units when tested under laboratory conditions."

A testing method using a water-cooled condenser and which permitted "on-and-off" operation, is described. Much of the bulletin is taken up by the printed data resulting from the tests.

No conclusions are included but the following statements occur under the head of "Summary."

(A) CONSTANT OPERATION

(1) With the conversion burners continuously operating in boilers of different sizes and dissimilar in construction, high thermal efficiencies were obtained.

(2) The efficiencies of the conversion burners were, in general, as good as were secured with boilers expressly built for gaseous fuel.

(3) As far as thermal efficiency is concerned, there is little to choose between the conversion units tested. The choice of unit to be installed must rest upon other factors.

(4) While the results obtained in the eight boilers built for solid fuel cannot be taken as indicative of the operation of conversion burners in all other makes and types of coal-designed boilers, the data obtained point strongly toward the conclusion that, when properly installed, a good gas conversion unit will operate well in any well-designed domestic steam boiler.

(5) The capacity tests conducted by the use of the method developed for these tests, produce results which do not differ materially from those obtained by the use of the American Gas Association method.

(B) INTERMITTENT OPERATION

(1) No claim is made that the results of the intermittent tests can be used to gauge the seasonal efficiency of gas-fired boilers, and this applies equally to conversion and gas-designed units.

(2) The data are not conclusive enough to indicate whether the results may be used to estimate the advantages of the two methods of heat application. Such a comparison, if valid, is entirely in favor of the conversion method.

(3) The results obtained during the intermittent tests show that testing a boiler under steady operation does not bring out its operating characteristics. They show that two boilers so tested may each reach equally high peaks of efficiency and still operate with divergent efficiencies during long off-periods.

(4) The intermittent tests lend data to support the belief that further study of such methods of testing with a view to setting up testing cycles which would be truly representative of operating conditions, would be a worth-while activity. If a laboratory method for so testing could be developed, it would be extremely useful in obtaining the operating characteristics.

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Some Fundamental Considerations of Corrosion in Steam and Return Lines

By R. E. Hall and A. R. Mumford

A.S.H.V.E. paper, annual meeting, Cleveland, January, 1932. About 20,000 words, 14 tables, unillustrated.

A discussion of the chemistry of the solvent action of water and its dissolved gases on iron and steel, is followed by a statement of the law of Henry and Dalton and its application to the problem of corrosion as encountered in heating systems. By this law the concentrations of carbon dioxide and oxygen possible are computed at several pressures. The computations show that corrosive action cannot be expected from the steam supplied.

Samples of steam were collected at points in a steam distribution network, at headers ahead of radiators, and ahead of the trap on the return line from a hot water tank. Samples of condensate were also collected. Analysis showed a greater concentration of gases in the condensate than in the steam. The authors believe that the excess must have reached the condensate from atmospheric supplies, i.e., that air in the system must be the source of the gases.

Further samples of condensate collected in buildings showed high concentrations of gases in the condensate. Here the authors believe there is no doubt but that the gases are supplied from the air which leaks into the utilization piping.

The authors suggest a limiting concentration of carbon dioxide of 15 to 20 parts per million in the supply steam as being a satisfactory tolerance to avoid difficulty from its presence. Likewise they feel that a similar tolerance for oxygen content may be set at 0.3 to 0.5 milliliters per liter. They feel also that since the corrosive gases enter from the atmosphere, it is more important in preventing corrosion that attention be given to these items than to small changes in the quantity of gases in the steam supplied.

The authors point out that corrosion takes place only when a metal surface is wet with the condensate which contains dissolved carbon dioxide and oxygen. Dry surfaces do not require protection. A means of combating corrosion on surfaces, therefore, is so to arrange them that they will drain and dry rapidly. Where surfaces must necessarily be wet, protective coatings over the surface constitute the main defense against corrosion.

Your Everyday Problems

Mr. Hanburger will be glad to answer your problems relating to installation and operation of heating and ventilating systems, and wherever possible will give the reasons for his suggestions. Letters will be answered direct to the inquirer and in some cases published anonymously. If sketches are included they should be clearly drawn. Write Mr. Hanburger, HEATING AND VENTILATING, 148 Lafayette Street, New York.

Conducted by FRED W. HANBURGER

QUESTION 25. A situation exists in many architects' and engineers' offices in regard to what is known as the Hartford Loop. We note that in most cases, regardless of the type of heating system used, a Hartford Loop is specified.

We have consulted with the Hartford Company. They state that the Hartford Loop was designed for gravity return systems only. *B. E. C.*

ANSWER. Even though some questions concerning the Hartford connection have already been answered in this column, there are so many oft repeated inquiries that it may be well to make a mental investigation into its operation and the principles under which it operates in as simple a manner as possible even though the discussion appear somewhat lengthy. To many of its adherents who install it blindly this may end in disappointment as to its merits but at the same time it may be beneficial in destroying a false feeling of security that obtains in the minds of many that with this type of connection it is impossible that the water disappear from the boiler.

Let us first take the elementary system of Fig. 1, without a check valve or Hartford connection and where C represents a condenser, or the combined radiation of a building. Any pressure drop that may occur through friction in the main S to supply C must be overcome by an increased water head in the return drop L before any water can be returned to the boiler.

Taking numerical values for the purpose of illustration let us assume that there is a friction pressure drop of 2 lb. per sq. in. through S to supply the demand of C. The steam pressure on the water column in the return leg L will then be 2 lb. per sq. in. less than the pressure in the boiler and, without a check valve or Hartford connection, the water will flow from the boiler through the return piping until it has created sufficient water head to balance the difference, which is approximately 2 lb. x 30 in. = 60 in., or 5 ft. This same condition will obtain whether the system be vacuum, vapor or low pressure.

In the case of Fig. 1 the 5 ft. height reaches approximately midway of the condenser or lower radiators as is shown by the plane lines on the right. As the radiator becomes water-logged its efficiency becomes diminished, less steam is demanded, the pressure loss becomes less, and the height reached in the return water column is somewhat less than 5 ft., but at all times lies somewhere in the lower radiator whether there be radiator traps or not. If the amount held in the radiators and in the dry return piping is more than the water capacity of the boiler, the boiler will go dry.

If a check valve be placed at V the water will no longer be forced backward along the returns, yet the same condition must be, and will be, reached by the water being carried forward as steam, condensing and being retained until it has a height sufficient to force the water back. When it has reached this point then each new drop of condensation formed forces a drop into the boiler.

After connecting this same layout with a Hartford connection as shown at H in Fig. 2 with the nipple at H, 3 in. below the mean boiler water line, it will be noticed that as soon as a rapid condensation occurs in C,

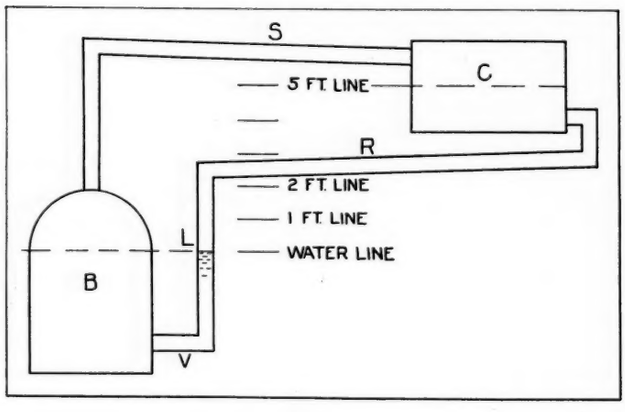


Fig. 1

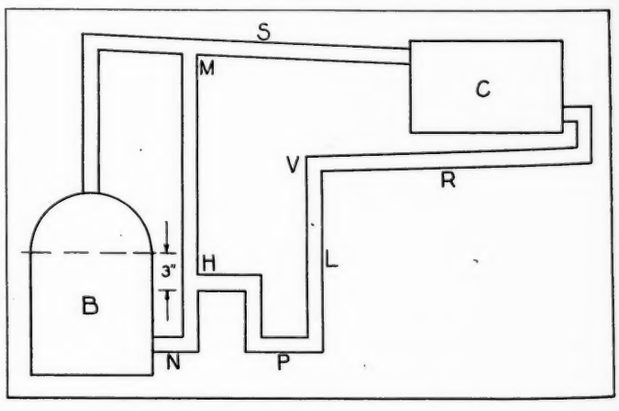


Fig. 2

the water will at once flow back along the returns until the water in the boiler has been lowered 3 in. or to the bottom of nipple H. Here the back flow or so-called siphoning ceases, because the steam pressure on the water column in the lower part of the equalizing pipe MN is the same as that in the boiler, but this same pressure is also exerted against the water in the return and once more all the water of condensation will be retained in the piping until sufficient water head has been attained to overcome the steam pressure.

If a condensation and vacuum pump were now installed at P the functioning of the Hartford connection would continue under the same conditions as prevailed before, except that the pressure necessary to force the water into the boiler would be furnished by the pump instead of by a built up water head. Since the Hartford connection does not have the sense to know how the pressure is furnished it goes right on functioning whether the system be the so-called vacuum, vapor or low pressure. The use of a pump at P would not necessarily make the system a vacuum system in the true sense of the word if the ordinary traps were used at the return end of the radiators, yet its installation would effectually cure the water-logging of the returns and lower radiators and thus save the boiler from going dry. It is the pump that accomplishes this, however, and not the Hartford connection. The only advantage that the connection has over the check valve is that it would not be affected by foreign substances in the water which might affect the operation of a check valve. Under proper conditions it can be used in any type of system.

This department is an open forum and I will be glad to entertain or discuss any other views on this subject.

QUESTION 26. In a school in N. Y. City are installed two compact welded type of boilers, each having a catalog rating of 25,500 sq. ft. of steam radiation and a grate surface of 39 sq. ft. These boilers are connected to a stack 56 in. in diameter having a height of about 90 ft. above the grates. The breeching has an area about 20% greater than that of the stack. The two boilers are large enough to handle a connected radiation in the building as designed with an outside temperature of 30° below zero when using 100% outside air in the unit heaters. One wing of the school has been left off, so that under present conditions we doubt if it will be necessary to operate both boilers at any time during the winter. One boiler was started up recently using splint coal from West Virginia, hand fired. The weather being very mild it was necessary to operate with an exceptionally low fire which will undoubtedly be the condition existing during a large part of every spring and fall. Under these conditions it was noticed that the flues of the boiler plugged up rapidly. Some claim that the cause of this was a lack of draft, so that we installed a draft gauge in the breeching where it enters the stack and found that our flue gas temperature was about 125° and the draft about 0.15 in. of water. W. O.

ANSWER. This condition occurs in so many cases when a boiler is being operated far below its rated capacity and especially so when a soft coal fuel is used and nothing is done to throttle the chimney. The consequence is that with a very slight rise in the stack temperature the chimney has developed sufficient power to draw an excess of air through the fire bed. When the excess air is sufficiently large it cools the gases below the combustion point and soot and smoke are carried up the chimney or deposited along its path. The flue draft readings and the stack temperatures that were taken clearly indicate this. One could safely make the assertion that if CO_2 readings were taken they would be found to be way below 10% and it is a rather safe general rule to make this amount the deadline minimum for good combustion.

Here we have one boiler operating with a chimney that was liberally designed for two. The area of the chimney is easily twice as large as one boiler would need when operating full capacity. To supply but one fire there would hardly be any resistance in the chimney itself and the only friction it needs overcome is that in the firebed itself.

The remedy would lie in throttling or dampering the smoke pipe connection to the stack, thus reducing the capacity of the chimney by creating additional friction. To overcome this added resistance the stack temperature will increase, the flue pressure will increase, and the velocity of the air flowing in the chimney will be greater. Even though the velocity of the air be greater, owing to the restricted opening, due to throttling, the amount of air will be considerably less and, therefore, flow more slowly through the firebed. This will produce a higher temperature and induce combustion in the combustion chamber where practically no combustion occurred before except in the section near the fire itself. A damper in the smoke pipe connection should accomplish this but with such a large smoke pipe it may be difficult and I feel that it would be better to first reduce the size of this pipe.

Properly throttled you should have a flue gauge reading of at least 0.30 in. and a stack temperature of somewhere around 300°.

Note—I am grateful for the many able and interesting discussions received in answer to Question 24, published in the November issue, regarding the flow of cold air into the chimney.

Additional discussions are invited, and the coming issue will contain the answers received up to January 10.

Your name will not be published if you wish.

F. W. H.

News of the Month

Forced Air Systems to be Investigated by N.W.A.H.A.

Announcement was made at the nineteenth annual convention of the National Warm Air Heating Association, held at the Mayflower Hotel, Washington, D. C., December 3-5, that the research work at the University of Illinois, financed by the association, will be concentrated on forced warm-air heating.

Although members feel that the greater part of the work still being done by installers is in the gravity field, nevertheless, the increasing importance of the fan systems, especially in connection with domestic air conditioning, warrants study of the forced air problems.

The convention was called to order by President I. L. Jones, who spoke briefly on the work of the association and the research residence. He stated that manufacturers have been adjusting themselves to conditions as they exist today.

Prof. F. W. Rowley, director of the experimental engineering laboratory, University of Minnesota, spoke on Air Conditioning in the Home. He pointed out that school ventilation started with attempts to regulate the quantity of air, and that other factors, such as temperature, humidity, air motion, distribution, purity, freedom from dust, odors or other harmful ingredients, were all given consideration later.

He emphasized the fact that distribution is an important factor from an economy standpoint, and has much to do with maintaining a minimum temperature variation between floor and ceiling.

The speaker stressed the importance of insulation and the prevention of in-leakage in connection with cooling work, stating that quite frequently losses due to leakage are responsible for increasing the cost of cooling a given volume of space.

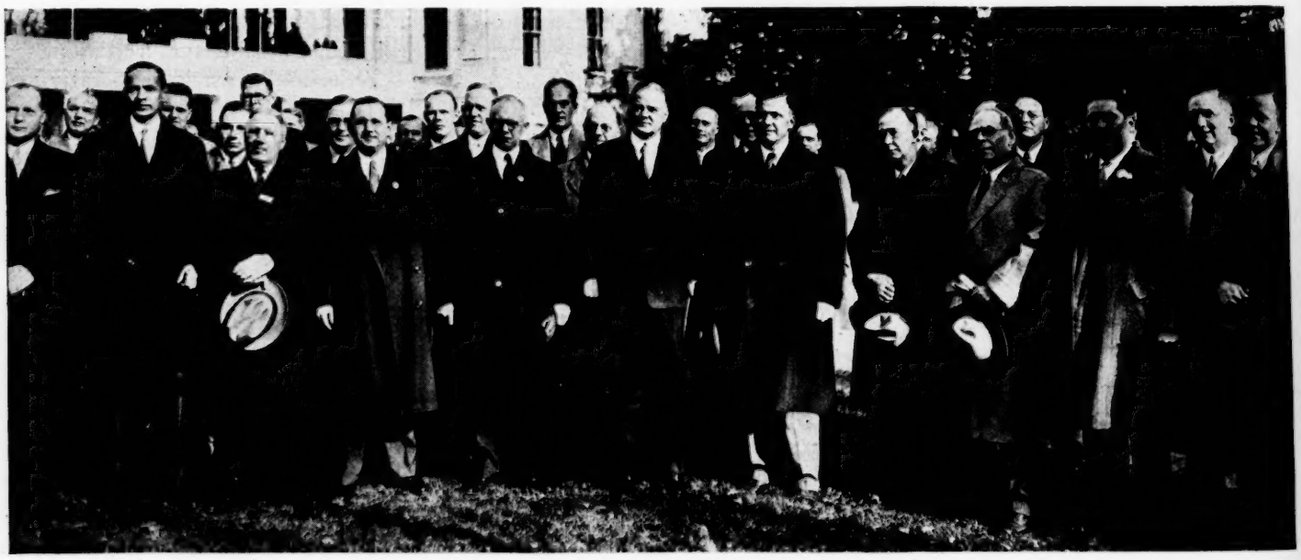
G. Olson, heating contractor, Omaha, Neb., presented his views on air conditioning in homes. Mr. Olson stated that this work is coming rapidly to the front, but many dealers still do not appreciate their opportunities. He pointed out that conditions now are reversed, in so far as public preference for warm-air heating is concerned. He said that he had lost only one job out of the last twenty-seven on which he had figured to radiator heating. It was emphasized that air conditioning should not be considered on a competitive basis by the heating contractor, but should be sold on its merit.

Prof. A. C. Willard, University of Illinois, explained that the research advisory committee had decided to discontinue all research work on gravity installations in the research residence, and devote all such work for the coming months to mechanical installations. The new plant will be ready by January 1, and it is planned to employ the present furnace and registers for the first floor and also the present wall stacks and registers serving the second and third floors.

Professor Willard explained that the research advisory committee had invited recognized engineers to submit their ideas on layout for the research plant. Eight such plans were submitted and these were shown by slides, as were the proposed plans as worked out by the research staff from the plans that had been submitted.

The objectives, he explained, are to develop performance and operating data with a view to developing proper methods of design and installation.

Dr. Hugh L. Dryden, of the Bureau of Standards, spoke on Relation of the Bureau of Standards to the Problems of the Heating In-



President Hoover greets warm-air heating men at the opening of the nineteenth convention of the National Warm Air Heating Association. Those in the first row, from left to right, are: Clarence Olson, president, Fox Furnace Company; A. W. Wreiden, treasurer, Holland Furnace Company; R. W. Blanchard, chairman of the membership committee, and president, Hart & Cooley Manufacturing Company; W. L. McGrath, vice-president of the association; I. L. Jones, president of the association, and president, International Heater Company; President Hoover; A. P. Lamneck, now congressman from Columbus, Ohio. From right to left: Gilbert Olson, Omaha, Neb.; H. T. Richardson, vice-president of the association, and vice-president, Richardson & Boynton; Allen W. Williams, managing director of the association.

dustry. He explained activities of the bureau, including the calibrating of heat and air measuring instruments.

Prof. J. D. Hoffman, chairman of the standard code committee, reported that there was nothing to recommend in the way of changes in the Standard Code, but that the industry is now looking to the development of a blower code. He explained that the committee was of the opinion that the compilation of a blower code must await information developed by the research work. He assured the Furnace Blower Manufacturers' Association that the committee is most willing to work with it in preparing such a code.

The following officers were elected for 1932: president, I. L. Jones; first vice-president, W. L. McGrath; second vice-president, H. T. Richardson; managing director, Allen W. Williams; board of directors, H. P. Mueller, R. W. Blanchard and F. E. Mehrings.

President Jones reappointed all committees, explaining that as they had served a short term he would now ask them to carry on for the current year.

President's Conference Discusses Home Building

Over two thousand leaders in the construction industry attended the President's Conference on Home Building and Home Ownership, held in Washington, December 2-5. The whole question of home building was considered, particularly the proposed reforms in tax laws and better methods of financing. In a more detailed way, all of the technical phases of the subject, including the heating and ventilating of homes, were discussed.

In his address, President Hoover proposed that financing be arranged for those prospective home builders who could make only a 20% or 25% down payment, and reviewed his plan for twelve special rediscount banks throughout the nation.

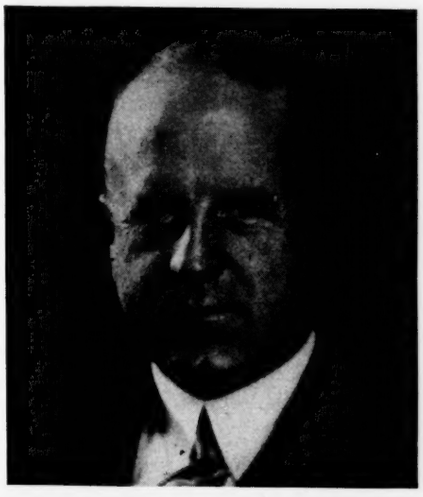
The proposed banks would cope with emergencies due to current business conditions and would make it possible to gradually work out the problem of systematically promoted home ownership on such terms of sound finance as people who have the home-ownership inspiration in this country deserve.

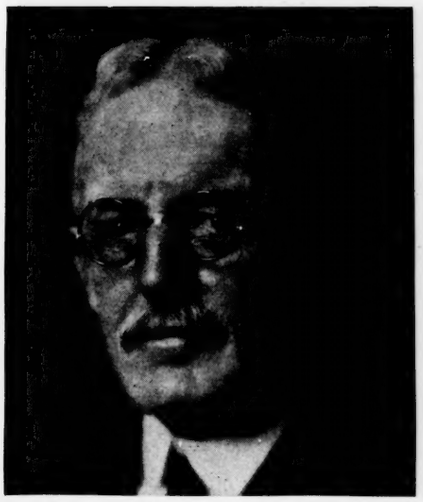
According to the President, the chief problem in finances relates to those who have an earnest desire for a home, who have a job, and, therefore, possess sound character credit, but whose initial resources run to only 20% or 25%. These people would willingly work and apply all their rent and all their savings to gain for themselves this independence and security and social well-being. Such people are a good risk. They are the very basis of stability to the nation.

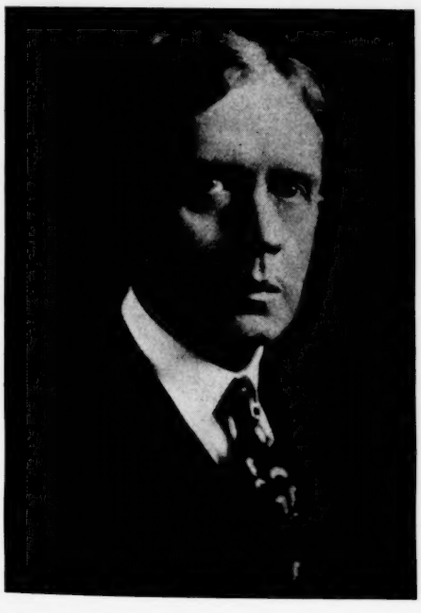
The conference, in one of the few resolutions that it adopted formally as a body, approved the President's banking plan. However, in its special report to the meeting, the committee on finance of the conference agreed only to a 25% down payment.

The question of taxation was introduced into the conference by Ray Lyman Wilbur, Secretary of the Interior. A study of existing real estate taxes revealed that the taxes have resulted in heavy and inequitable burdens and that home ownership under the present system of taxation has been discouraged.

The conference paved the way for a reform in these tax laws by urging that a thorough study be







Four of the five engineers who prepared the report of the committee on fundamental equipment for the President's Conference on Home Building and Home Ownership. Dean Collins P. Bliss, of the College of Engineering, New York University, above, was chairman of the committee; Prof. Arthur C. Willard, left, W. H. Driscoll, top, Philip Drinker, right, and Perry West, not shown, prepared the report.

made of alternative methods of raising revenue so that the burden said to exist on home building in this regard could be removed.

The committee recommended to all home buyers the advantages of long term amortized loans, and where there is a second mortgage that the principal installments be deferred to the end of the second or third year.

A group of 31 committees appointed earlier this year presented exhaustive reports on the results of their investigations, which covered every conceivable phase of the home problem, including city planning and zoning; types of dwellings; design; construction; housing and the community; subdivision layout; kitchens and other work centers; negro housing; blighted areas and slums; household management; taxation; reconditioning, remodeling and modernizing; relationship of the home and income; and farm and village housing.

Through the reports dealing with specific phases of construction, the committee sought to set standards for the work to be done, thus encouraging construction by providing a basis for uniformity and offering protection to the home-owner who followed the standards.

Heating Engineers and Refrigerating Engineers to Share Honors at Cleveland

Final preparations are being made for the Second International Heating and Ventilating Exposition, to be held in Cleveland, January 25-29, in conjunction with the annual meetings of the American Society of Heating and Ventilating Engineers and the American Society of Refrigerating Engineers.

The two societies will have separate headquarters; the A.S.H.V.E. at the Hotel Statler, and the A.S.R.E. at the Hotel Cleveland. On two of the days, however, the two societies will hold joint meetings in the Little Theater of the Cleveland Auditorium, adjoining the Exposition Hall.

The technical program of the A.S.H.V.E. follows:

TUESDAY—JANUARY 26

Morning Session

Surface Coefficients as Affected by Direction of Wind, by F. B. Rowley and W. A. Eckley.

Conductivity of Concrete, by F. C. Houghten and Carl Gutberlet.

Afternoon Session

Importance of Radiation in Heat Transfer through Air spaces, by E. R. Queer.

Heat Emission from Iron and Copper Pipe by F. C. Houghten and Carl Gutberlet.

Hot Water Friction Heads in One Inch Cast Iron Tees, by F. E. Giesecke and W. H. Badgett.

Some Fundamental Considerations of Corrosion in Steam and Condensate Lines, by R. E. Hall and A. R. Mumford.

WEDNESDAY—JANUARY 27

Morning Session

Joint meeting with the A.S.R.E.

Field Studies of Office Building Cooling, by S. S. Sanford, E. P. Wells and J. H. Walker.

Acoustical Problems in Heating and Ventilating of Buildings, by V. O. Knudsen.

Changes in Ionic Content of Air in Occupied Rooms Ventilated by Natural and by Mechanical Methods, by C. P. Yaglou, L. C. Benjamin and S. P. Choate.

Heat Transmission as Influenced by Heat Capacity and Solar Radiation, by F. C. Houghten, J. L. Blackshaw and E. M. Pugh.

THURSDAY—JANUARY 28

Morning Session

Joint Session with the A.S.R.E. (See A.S.R.E. Program)

Afternoon Session

Report of Committee on Ventilation Standards, by W. H. Driscoll.

FRIDAY—JANUARY 29

Morning Session

A study of Intermittent Operation of Oil Burners, by L. E. Seeley.

Room Warming by Radiation, by A. H. Barker.

A Study of the Combustible Nature of Solid Fuels, by R. V. Frost.

Papers on the A.S.R.E. program of interest to heating and ventilating engineers will be:

Application of Refrigerating Machinery to Heating and Cooling of Houses, by F. H. Faust, E. W. Roessler and A. R. Stevenson, Jr.

Air Conditioning Applied to Cold Storage, Including a New Air Conditioning Chart, by C. A. Bulkeley.

Biological Aspects of Thermal Engineering, by S. R. Prescott.

The above papers will be presented at the joint session, Thursday, January 28.

Approximately 230 exhibitors will show their products at the Exposition, which will be held in the Annex to the Cleveland Auditorium. The Exposition will be open from noon till 10 p.m.

November Temperatures Highest in Sixty Years

According to the records of the United States Weather Bureau, the average temperature for November, 1931, was the highest on record in the past sixty years. To the already large excess in temperature for this year, the month of November added a daily departure above normal of 7.3° at New York; 7.4° at Boston; 8.4° at Pittsburgh; 9.4° at St. Louis; and 9.9° at Chicago. These figures indicate the broad area, including the north and central plain states and the North Atlantic states, in which all records of monthly average temperatures were broken.

Cleveland Organizes Group to Further Coal Heating

Under the leadership of H. L. Findlay, vice-president of the Y. & O. Coal Company, and Henry M. Brown, of the stoker division of the Pocahontas Fuel Company, preliminary steps have been taken for the organization of a Cleveland group of coal and related equipment interests to cooperate with the Committee of Ten.

A tentative organization, with Mr. Findlay as chairman and Mr. Brown as vice-chairman and secretary, was effected at a meeting of about twenty representatives of the

related industries, held at the Union Club, Cleveland, November 16. The functions of the Committee of Ten were explained by Managing Director Oliver J. Grimes, of Chicago, and the field of activity and the benefits of local organizations were discussed by Fred W. Braggins, president of the Lorain Coal & Dock Company, of Columbus, who is one of the organizers of the Columbus local group.

The organization committee designated at the meeting includes Mr. Findlay, chairman; Mr. Brown, vice-chairman and secretary; B. Y. Kinzey, manager, Heating & Piping Contractors Cleveland Association; H. S. Sharp, vice-president, Henry Foundry & Furnace Company; O. F. Wilkinson, City Ice & Fuel Company; Whitney Warner, W. H. Warner & Company, and Wirt Griggs, branch manager, Minneapolis-Honeywell Regulator Company.

Lewis Addresses Western Engineers

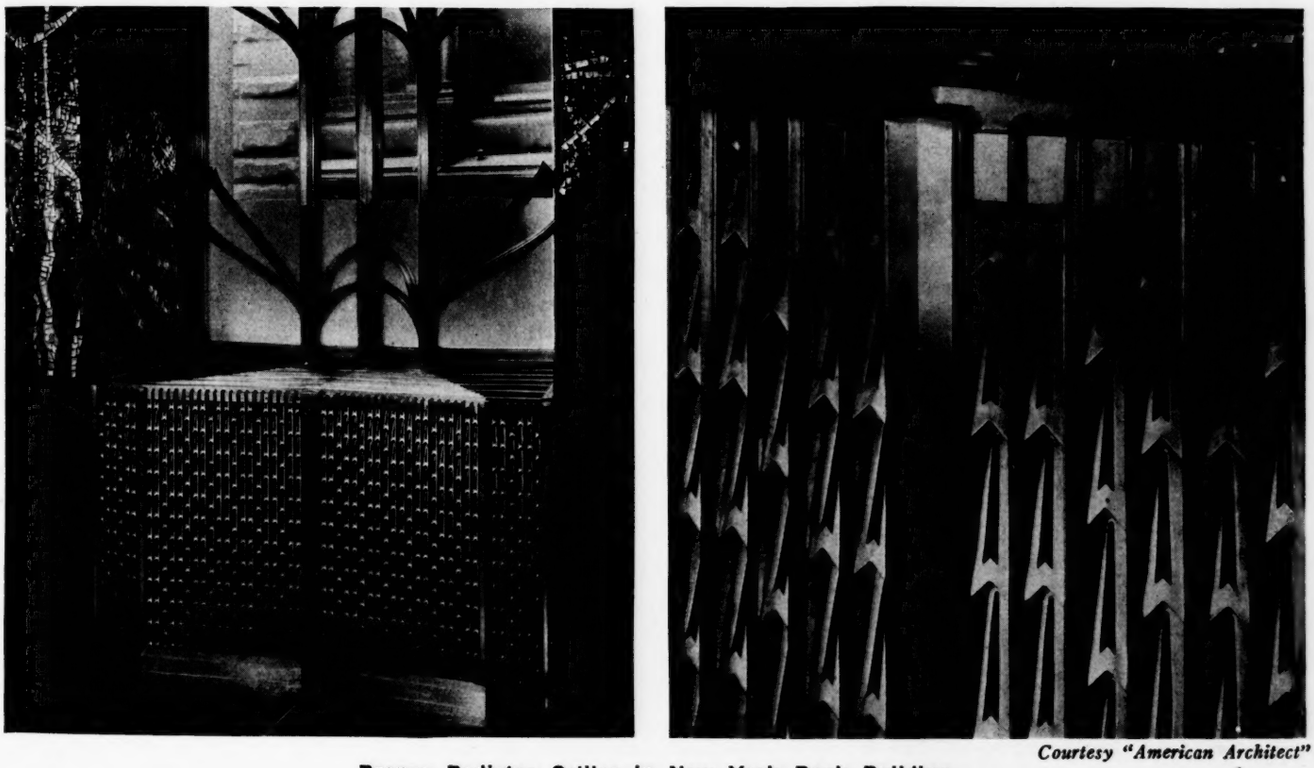
At a meeting of the Western Society of Engineers, held in Chicago, November 16, S. R. Lewis, consulting engineer, explained how the ventilating engineer can provide comfortable living and working conditions throughout the year using the same equipment both summer and winter. Such a high load factor of use of apparatus should appeal to every engineer. Taking a typical office building for example, he analyzed the requirements of an ordinary office and then showed how it would be possible to provide air at the best temperature the year round.

In the case of a skyscraper, a central heating and ventilating plant does not appear to be so economical as a separate system for each floor, or perhaps each pair of floors, with motors and fans serving just the area required with a minimum of ducts and no risers. The temperature is controlled by coils heated by steam in the winter and cooled by a refrigerant in summer. He showed some of the more common errors made in locating inlets and outlets, many of which are due to the fact that the designers have overlooked the principle that cold air delivered from a duct will fall to the floor just as positively and almost as quickly as cold water. He included some estimates of cost which might be summarized in the statement that an increase of twenty-five cents per square foot in the rent would pay all the costs of cooling for comfort and proper air conditioning in addition to the minimum heating ordinarily supplied.

At the conclusion of the meeting, Mr. Lewis exhibited an interesting model which he had built in a study of some special air conditioning and smoke removal problems.

Bituminous Coal Conference Hears Papers on Stokers and Smoke Abatement

The economic difficulties of the bituminous coal industry occupied the most prominent part on the program of the Third International Bituminous Coal Conference, held at Carnegie Institute of Technology, Pittsburgh, November, 16-21. However, there was no lack of interest and discussion on technical subjects,



Courtesy "American Architect"

Bronze Radiator Grilles in New York Bank Building

The illustration to the left shows one of the unusually attractive enclosures used in the main reception room of the Irving Trust Company Building, the view to the right being a close-up. The front is made up of vertical fins of extruded bronze with small louvers between them, all soldered at the back. The tops are formed of zig-zag louvers cast of bronze. Voorhees, Gmelin & Walker were the architects; Clifford Parkhurst was the consultant on the bronze work.

and the large attendance and active discussion at the session devoted to small industrial and domestic stokers showed that the coal industry is aware of the competition of oil and gas in the heating field.

The majority of the smaller industrial stokers are generally reliable and satisfactory, according to a series of tests on five well-known makes by Profs. G. A. Young and W. T. Miller of Purdue University. On 12 hr. reliability test runs, operating automatically, these stokers showed average efficiencies of 68% to 71% at about 100% of boiler rating. On maximum test runs, operating partly automatic but with as much manual adjustment of the fire as was necessary, these stokers operated satisfactorily up to 220% of rating, with heat releases varying from 32,000 to 43,000 B.t.u. per cu. ft. of furnace volume per hr. and for varying time periods.

Professor Young stated that the most common error made in the purchase and installation of small industrial stokers was in the choice of the wrong size for the coal to be used. To operate such installations satisfactorily, they were frequently shifted to the best, and, consequently, highest-priced, grades of special stoker coal, thereby nullifying the stokers' most effective claim—use of the cheaper grades of bituminous coal.

In a paper on "Domestic Stokers," Walter Barnum pointed out that the oil and gas industries have aroused a desire for clean automatic heat and have attempted to meet this desire for heating service. The coal industry, on the other hand, has been slow in recognizing this public demand, but is now in a position to supply it at a cost less than is possible with either oil or gas.

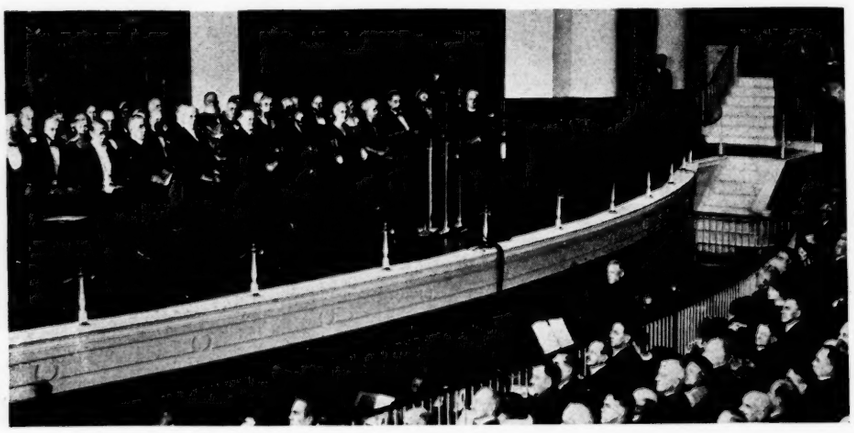
While domestic stokers have been available for some little time, it is only recently that completely automatic machines, handling several kinds of bituminous coal, including slack and coking coals, have appeared on the market. These stokers, according to Mr. Barnum, fire the fuel automatically, burn it smokelessly at efficiencies of 70% to 75%, tests in homes showing 14% to 16% CO_2 continuously for days at a time.

Smoke and dust abatement occupied an important place on the program. In relating what is being done in England, Prof. C. H. Desch told of the distinction there being made between preventable and unpreventable smoke. Steam boiler and heating furnaces, as well as certain industrial operations, fall within the former class, to which stringent measures are being applied. Other industrial processes, including metallurgical furnaces and bessemer converters, fall within the second class.

Complete elimination of smoke was advocated by Victor J. Azbe, St. Louis, consulting engineer. In his opinion, prevailing smoke ordinances will never produce a clean city, because they generally permit continuous smoke of less than No. 3 density and denser smoke for brief periods. More stringent laws are necessary, rigidly enforced, and backed up by a citizens' smoke abatement league in every city. Domestic furnaces in many localities, in the aggregate, are admittedly the greatest offenders and the hardest to control, but Mr. Azbe believed that an effective remedy lay in the employment of a downdraft baffle, so that the sequence of combustion and flame travel would always be from fresh to burning coal and never the reverse.

A. D. Bailey, of the Commonwealth Edison Company, Chicago, heartily endorsed the aims of the A.S.M.E. Pure Air Committee to approach the problem constructively and bring together the various interests concerned. In his opinion, the real solution to the problem, especially as concerns the domestic consumer, rests in the supply of the proper fuel.

In discussing Mr. Azbe's paper, George A. Orrok took the position that there is no reason to expect any larger reduction in dust and smoke, as the public, to date, has not shown any willingness to pay the cost. Dust, in his opinion, is more serious than smoke, and in certain localities sulphur fumes are factors.



President Hoover Opening National Conference on Home Building

A scene in Constitution Hall, Washington, D. C., just before President Hoover opened the National Conference on Home Building and Home Ownership. The conference was formed upon the President's suggestion to stimulate construction.

Pittsburgh Heating Engineers Discuss Air Conditioning

Fifty members and guests attended the annual meeting of the Pittsburgh chapter of the A.S.H.V.E., held December 7. The speaker of the evening was John R. Hertzler, manager of the air conditioning department, York Ice Machinery Corporation, who spoke on Refrigeration as Applied to Air Conditioning.

Mr. Hertzler told of the early history of air conditioning, which, he said, began with the work of Joseph McCreary, who in 1896 planned to refresh air by passing it past plates over which water flowed. He illustrated with slides many of the early bulky types of refrigerating machines and compared them with the compact modern machines of identical capacities. He showed the arrangement and operation of a

typical air conditioning system, and explained different types of refrigerating plants. The component parts of refrigerating plants — compressors, evaporators, and condensers— were illustrated and discussed in detail. In concluding his talk, the speaker summed up the factors which must be considered in the selection of a refrigerator. These are: required load, load factor, basis of fixed charges, number of hours system is to be used, operating charge, flexibility of operation, space utilized, dependability, safety, and noise.

The following officers were unanimously elected: president, R. B. Stanger; vice-president, F. C. McIntosh; secretary, J. L. Blackshaw; treasurer, H. B. Orr; board of governors, F. C. Houghten, G. S. McEllroy and H. Lee Moore.

Air Pollution by Smoke Abated 60% in New York

According to Health Commissioner Dr. Shirley Wynne of New York, air pollution by smoke in New York has been abated 60% as a result of the activities of the smoke abatement commission. Findings of the Department of Health smoke abatement commission are sustained in a report of the committee on public relations of the Academy of Medicine, made public September 28.

Agreement is reached with the commission that sulphur (in the form of sulphur dioxide and sulphuric acid), arsenic, carbon monoxide, carbon dioxide and chlorine and nitrogen gases are the most common substances which pollute the air and that all of them are found in smoke. About four tons of these solids of smoke, including soot, are deposited each month on every square mile of the city, the report asserts.

Authorities are quoted to show that sulphur compounds are objectionable and probably more harmful than carbon compounds in smoke. Asthma and tuberculosis are both promoted by them, it is said. Findings of Prof. Yandell Henderson show that under certain atmospheric conditions, where there is little breeze stirring and traffic is heavy, the carbon monoxide content of the street air in New York reaches a point where prolonged and continuous exposure to it may have deleterious effects.

That air pollution exists in the city of New York is shown by the fact that deposits in New York in 1930 averaged 3.97 tons per square mile a month. The United States Public Health records showed a large relative loss of light and health-giving rays in New York City in 1927 and the presence of soot was a contributing factor. In some cases the average hourly or daily loss was greater than 50% and the average daily loss for the year was 21.5%.

U. of Kentucky and C. & O. to Test Stokers

A cooperative arrangement has been effected between the Chesapeake & Ohio Railway and the college of engineering, University of Kentucky, to study the adaptability of coals mined along the line of the C. & O., for domestic purposes, particularly their adaptability to use in small stokers. The work contemplates an exhaustive study of coals from sixteen mines and includes the following activities: Boiler tests using stokers for firing; calorimeter determinations; proximate chemical analysis, and ultimate chemical analyses.

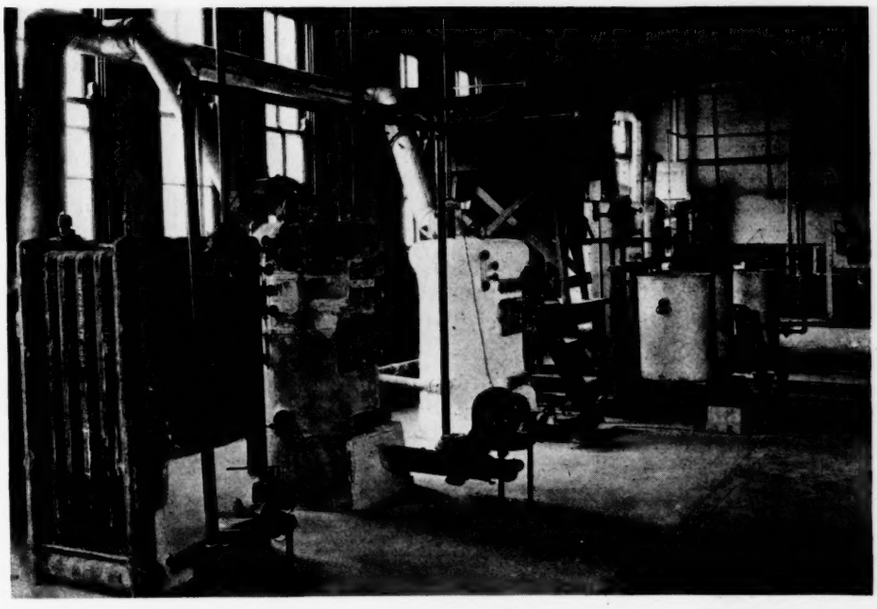
The project is under the direction of Dean F. Paul Anderson, of the college of engineering, University of Kentucky. Results of the study are to be embodied in a report for general distribution to engineers.

Federal Building Commission Investigating Government Building Projects

Collection of data and development of facts regarding the investigation of the building material industry by the Federal Trade Commission is under way.

The committee is acting under the direction of a Senate resolution passed at the Seventy-first Congress.

In this inquiry, the commission will investigate and report facts relating to the letting of contracts for the construction of Government buildings, particularly with a view of determining whether or not there are or have been any price fixing or other agreements, understandings, or combinations of interests among individuals, partnerships or corporations engaged in production, manufacture, or sale of building materials with respect to the prices



Gas conversion burners under test at Purdue University. The tests, recently completed, are described in "Tests of Gas Home-Heating Equipment," published by the university.

or other terms at or under which such material will be furnished contractors or bidders for such construction work.

Air Conditioning Design Forms

Engineering data sheets, designed to facilitate the calculation and recording of data worked up in connection with laying out residential air conditioning systems, are being sold by Mont H. Smith, Jr., 437 Lancaster Ave., Lancaster, Pa. The price is $3 for 25 sheets, with lower rates for quantity orders.

Pittsburgh Cooperates with Committee of Ten

As a result of a meeting of representatives of coal and related industries at the Fort Pitt Hotel, Pittsburgh, November 19, a general committee and a sub-committee were designated to undertake the organization of a Pittsburgh local group to cooperate with the Committee of Ten, Coal and Heating Industries. J. F. Flood, manager of the retail department of the Pittsburgh Coal Company, was named chairman of the general committee, and James Ward, III, of the East Liberty Coal and Supply Company, was designated secretary.

The general committee is composed of Mr. Flood and Mr. Ward; George H. Love, assistant to the president, Union Collieries Company; C. S. B. Ward, president, Weiman & Ward Company, representing wholesale coal; W. J. Keist, W. J. Keist & Son, warm-air heating; Joseph McGinness, Smith & McGinness, heating and piping contractors; R. W. Kiser, R. W. Kiser Coal Company, retail coal merchants; E. H. Eggleston, American Radiator Company; E. H. Reismeyer, president, Schaffer Heating Company, sheet metal contractors; L. A. Bell, Bartley-Oneil & Company, stokers; F. C. Houghten, A.S.H.V.E.; A. J. Miller, Davison Coke & Iron Company, coke; T. F. Campbell, T. F. Campbell & Company, heat controls; R. V. Bingay, Pittsburgh Stove & Range Company, furnace manufacturers; H. B. Meller, chief, Bureau of Smoke Abatement, smoke abatement; and J. B. McCorkle, coal traffic manager, Pennsylvania Railroad.

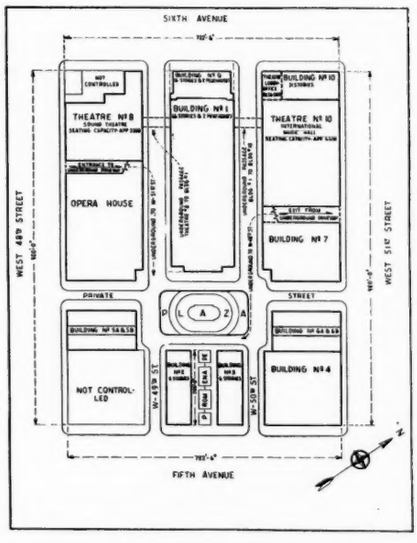
Health Service Studies Air Pollution in Fourteen Cities

Two overlapping surveys on air pollution are being made by the U. S. Public Health Service in 14 large cities. The first study will determine the amount of smoke, dust and other foreign matter which exclude the beneficial ultra-violet rays of the sunlight.

The second survey is directed at carbon monoxide gas from automobiles, and will also determine what other poisonous substances the city dweller inhales in his daily life.

Both surveys will require about a year for completion, and the results will probably be announced through the public health offices in the cities where investigations are made.

The cities in which investigations are being conducted are: Boston, New York, Philadelphia, Baltimore, Washington, New Orleans, Los Angeles, San Francisco, St. Louis, Chicago, Detroit, Cleveland, Buffalo, and Pittsburgh.



New York's Radio City in Plan

This plan of Radio City shows several changes from the original layout, which created considerable adverse comment when released. The development covers three city blocks, with the exception of two small portions.

Carbon Monoxide Indicators on the "Akron"

Two continuous carbon monoxide indicators have been installed on the Navy's new dirigible, *Akron*. The indicators were developed by Dr. J. J. White, lieutenant commander, Bureau of Medicine and Surgery, U. S. Navy; C. E. Earle, Bureau of Aeronautics, U. S. Navy; and the Mine Safety Appliances Co., Pittsburgh.

The ship is heated by means of a system of coils and pipes which circulate over the exhaust manifolds of the engines. The sampling lines of the indicators are connected to the heating duct, and percentages of carbon monoxide as low as .01 are detectable. Should a leak occur, the instruments are so designed to flash a red light in the engine compartment and sound a buzzer in the control car.

District Steam for Radio City

Contracts to supply steam for 20,000 radiators and other heating facilities to be installed in the ten units of Radio City, have been awarded to the New York Steam Corporation.

According to an announcement by the New York Steam Corporation, the work of installing underground connections between the new buildings has already been begun. More than 500 carloads of coal will be required, it was estimated, to produce the 360,000,000 lb. of steam needed annually for the broadcasting and amusement center.

Committee of Ten Discusses Use of Coal for Air Conditioning

With every cooperating industry except one represented, the Committee of Ten held its final meeting of the calendar year at the Union League Club, Chicago, November 23. Chairman J. H. Walker of the Research Committee presented a

report covering current research in coal and its utilization, and suggested that the committee might devote some attention to the use of coal in connection with silica gel air conditioning. The research committee was requested to assemble available data in that connection and to make a report for consideration at the next general meeting.

Anti-Utility Merchandising Law Upheld

The constitutionality of the Kansas Law commonly called "The Utility Merchandising Act," denying public utility companies the right to engage in retail mercantile business, was upheld October 28, 1931, by Judge Otis S. Hungate in the District Court of Shawnee County, Kansas. Attorneys for the utility companies have filed notice of appeal to the State Supreme Court.

A.S.H.V.E. Officers Address Buffalo Engineers

On November 9, the Western New York Chapter of the A.S.H.V.E. was host to the national officers and council of the society. The local chapter board of governors and officers attended a luncheon at noon at the Hotel Statler with the officers.

Willis H. Carrier, national president, was introduced as the speaker of the evening on the subject Servicing the Human Power Plant. The effect of temperature, humidity and air motion on the comfort of individuals was shown by a series of slides and ably explained by Mr. Carrier. The unique function of the human body automatically to adjust itself to existing air conditions was described. Mr. Carrier then discussed the efforts of the society committee now working on a code of ventilation and asked for comments. Then followed an open discussion on the subject by the following: J. J. Aeberly, W. H. Driscoll, A. C. Willard, J. R. McColl, F. P. Anderson, C. L. Riley, W. A. Rowe, L. A. Harding, and Hugo Hutzell.

It was the consensus of opinion of those present that the ventilation code should be adopted by the society when presented at the Cleveland meeting, not necessarily as a perfect solution to this problem, but as a beginning toward that end, the committee to be continued to make amendments as experience with the code demanded. The attendance at the meeting numbered 117.

Second International Heating and Ventilating Exposition Supplement

All subscribers to HEATING AND VENTILATING will receive, without cost, a copy of the Second International Heating and Ventilating Supplement, which will be published in January, 1932. The Supplement will contain the programs of the meetings of the A.S.H.V.E. and A.S.R.E., a guide to the exhibits, and other valuable features of interest and value.

Water Ends Smoke Evil

A successful method of washing coal smoke with plain water carrying a little iron and manganese has been perfected at the University of Illinois.

When smoke is bubbled through this mixture virtually all the sulphur dioxide is removed. This invisible gas is credited with destroying millions of dollars' worth of paint and metal surfaces in the United States annually. The discovery was reported to the International Congress on Bituminous Coal by Professor H. F. Johnstone, of the University of Illinois Engineering Experiment Station.

COMING EVENTS

JANUARY 25-28, 1932. Joint-Annual Meeting of the American Society of Heating and Ventilating Engineers, and the American Society of Refrigerating Engineers, at Cleveland.

JANUARY 25-28, 1932. Second International Heating and Ventilating Exposition, at Cleveland, Ohio.

JANUARY 25-30, 1932. National Association of Sheet Metal Contractors, Louisville, Ky. E. M. Pope, Chairman, Publicity Committee, 58 W. Washington St., Chicago.

APRIL 11-16, 1932. Ninth Annual Convention and Oil Burner Show of the American Oil Burner Association, Mechanics Building, Boston, Mass.

JUNE 14-27, 1932. Annual Convention of the National District Heating Association, to be held in Pittsburgh, Pa. Headquarters at the William Penn Hotel.

JUNE 20-23, 1932. Fiftieth Annual Convention and Exhibit of the National Association of Master Plumbers, at Madison Square Garden, New York.

JUNE 26-30, 1932. Semi-annual Meeting of the American Society of Heating and Ventilating Engineers, to be held in Milwaukee, Wis.

Edward D. Boech

Edward D. Boech, retired superintendent of the American Radiator Company's foundry in Buffalo, N. Y., died November 1, in Buffalo.

Mr. Boech, who was 74 years of age, was employed by the American Radiator Company for 44 years. In 1902, he went to Schoenback, Germany, to direct the opening of a company plant there.

Harry N. Leadbetter

Harry N. Leadbetter, president of the Dominion Radiator and Boiler Company, Ltd., Canada, died December 3.

Mr. Leadbetter became head of the Canadian interests of the American Radiator Company in December, 1912, a position he held until the time of his death.

Harry T. Wickes

Harry T. Wickes, president of Wickes Brothers, the Wickes Boiler Company, and the Arlington & Curtis Manufacturing Company, Saginaw, Mich., died November 20 in Pasadena, Cal.

Mr. Wickes, who was born on November 2, 1860, in Flint, Mich., was in ill health for the past several years.

John Bryan Teesdale

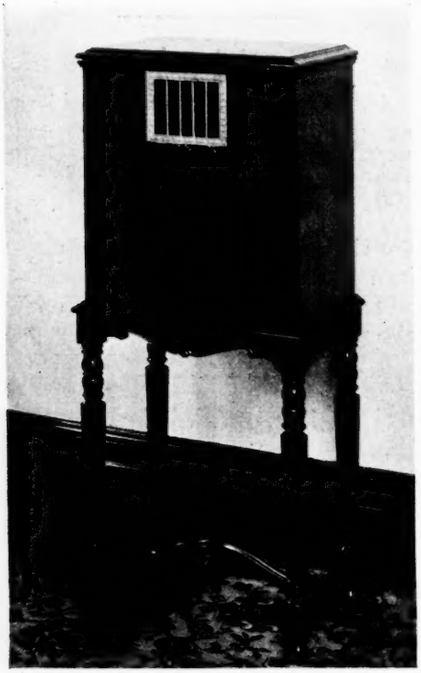
John Bryan Teesdale, inventor and owner of important patents in the oil heating industry, died on October 27, at the age of 75, in Grand Rapids, Mich., at the home of his son, Clyde H. Teesdale, president of the Teesdale Manufacturing Company.

New Equipment

Portable Humidifier

A portable humidifier, designed for use in homes, apartments, and offices where the company's regular line of humidifiers cannot be used due to the difficulty in securing available water, has been announced by the Wilcolator Co., Newark, N. J., under the name of the Portable Aqualator.

The device is enclosed in an attractive walnut cabinet. Water is evaporated by the centrifugal disc method, the disc being operated by a vertical shaft motor. The auxiliary motor-driven fan discharges the water vapor into the air. There are two removable tanks in the humidifier, each of which holds 2½ gal. of water, sufficient for about 15 hr. continuous operation.

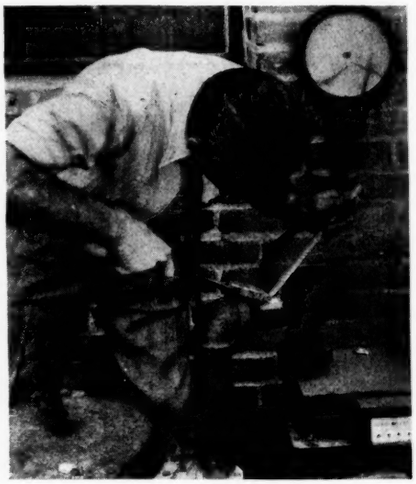


Portable aqualator

The device will be sold for $100.

Solder for Cast Iron Repair

A solder that will repair cast iron pipe, has recently been invented by the Allied Research Laboratories, Glendale, Cal. The solder is known as Alumaweld, and it is claimed that it will repair any metal, including cast iron, steel, aluminum, pot metal and die castings.



Repairing a pipe nipple with Alumaweld

Tests in which Alumaweld has repaired pipes indicate the simplicity of this new solder. The broken part is cleaned and then heated with an ordinary soldering iron. Then the solder, with a special flux, is applied, and the repair completed. Average pipe repair jobs take from 10 to 12 min., and are made without tearing down the pipe system.

Alumaweld has already been used extensively for the repair of steam and water pipes, heating plants, crank cases and cylinder heads on automobiles and tractors, aluminum pots and pans, vacuum cleaners, washing machines, and a host of other metal repairs.

Alumaweld breaks down the structure of the metal to which it is applied and fuses or welds with it. It is ten times as strong as ordinary solder, quite ductile, and will take a nice polish over which chromium plating or any other plating can be applied. It will not corrode under ordinary circumstances and cannot possibly rust.

Alumaweld can be used by anyone regardless of experience. It replaces welding at a fraction of the time and cost, without any danger of cracking during preheating and cooling.

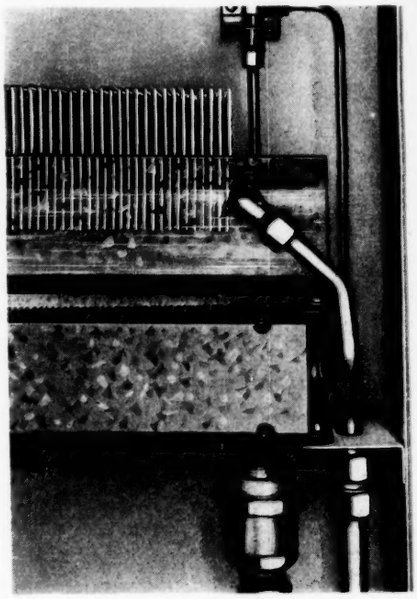
Badger Self-Equalizing Expansion Joint

E. B. Badger & Sons Co., Boston, Mass., is marketing its improved expansion joint, in which everdur metal is used. It is claimed that the new corrugation and equalizing ring eliminate all localized flexing stresses and insure complete distribution of the flexing regardless of the temperature or pressure. The everdur metal is said to have all the advantages of copper, and in addition, a greater tensile strength.

When in operation, the flexing movement of the corrugation flows back and forth over the curved surface of the equalizing ring, distributing the stresses uniformly throughout the entire corrugation. The movement can be said to be undulating, an action that can be seen in the joint with the ring cut away. The movement is equalized at all times because it cannot stop at any point and build up stresses. It is directed because the matched contours of the ring and of the corrugation force the flexing member to assume the correct position at all times.

Trane Humidifier

A convection humidifier has been announced by The Trane Co., La Crosse, Wis. The unit has been developed as a part of the company's convection heater, but may be in-



Trane humidifier

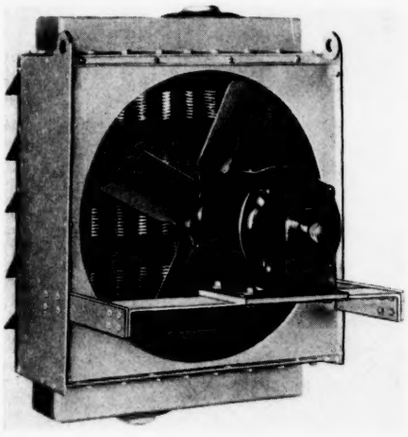
stalled in a cabinet on any steam or hot water heating system.

The operation principle differs from that of the steam or water jet type of humidifier, in that it does not force moisture into the air. The heated air, passing over a saturated wood fibre surface, is said to absorb the proper amount of moisture to keep the air in the building at the proper point.

The humidifiers will be sold as a part of the heating system in new installations and may be installed in the wall. In buildings already erected, the humidifier will simply be connected to the regular heating system.

McCord Unit Heater

The McCord Radiator and Manufacturing Co., 2587 East Grand Blvd., Detroit, Mich., has completed



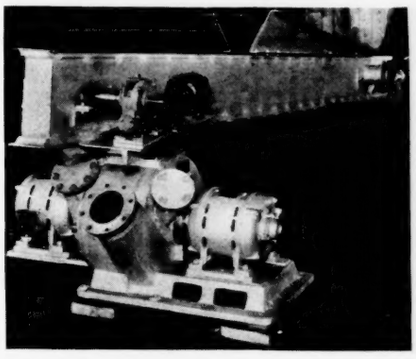
McCord unit heater

plans for the manufacture and marketing of the McCord unit heater. A new type of wide fin made of spirally wound copper will be used, the wider area balancing the ratio between tube surface and fin surface.

It is claimed that accessibility and convenience are among the points emphasized, motor and fan being easily removable independently of the rest of the unit. All parts can be removed for cleaning with minimum disturbance to the rest of the unit. The spiral fin tubes can be removed independently.

Holbeck Coal Pulverizer

The Holbeck Direct Firing Unit Corp., Cleveland, Ohio, has placed on the market a coal pulverizer which blows the powder through the pipe directly under the heater.



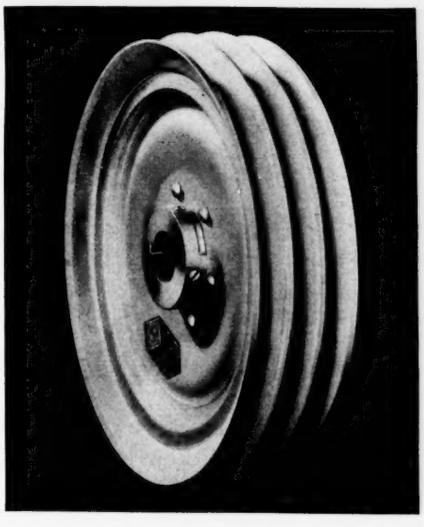
Coal pulverizer

Pulverizing is accomplished by the centrifugal action of two opposed rotors whipping up the coal. The rotors revolve in opposite directions about one-quarter of an inch apart, and are operated by two ball-bearing electric motors.

The unit is controlled by a room thermostat and by a limit control. The 12 in. size unit has a capacity from 500 lb. to 600 lb. of coal per hr. The 9 in. size has a capacity from 50 lb. to 150 lb. per hr. Larger sizes are made with capacities up to 25 tons per hr.

Allis-Chalmers Sheaves for Texrope Drive

To meet the demand for a lightweight low-priced drive, the Allis-Chalmers Mfg. Co., Milwaukee, Wis., has brought out a new pressed steel Texrope sheave, and complete Texrope drives using these sheaves are now available. The sheaves are



Sheaves for Texrope drive

die-pressed and then each section is welded both at the web and at the rim to eliminate vibration and noise and to give accurate balance. They are manufactured in a large range of diameters, permitting ratios as high as 6 to 1.

Gas-Aire Conversion Burners

A line of gas conversion burners made in three stock sizes is being marketed by Gas-Aire, Inc., 40th St. and Perkins Ave., Cleveland, Ohio.

Gas is reduced to an extremely low pressure and by the use of a blower the gas and air are mechanically mixed. The burner head is of direct heating design made up of an assembly of metal segments which form a circle of rectangular orifices.

The three models are named the Gem, Standard and Master. The former is designed for boilers and furnaces with grate diameters not exceeding 26 in. The Standard is made for round and square boilers with grates not over 30 in. to 34 in. The Master is for boilers not exceeding grate lengths of 36 in.

Special installations can be made where necessary.

Small Blower for Boiler Manholes

Coppus Engineering Corp., Worcester, Mass., has developed a boiler manhole blower with a capacity of 950 c.f.m., smaller than any the company has previously placed on the market.

The unit weighs 68 lb. It can be used as an exhauster also and has uses in rapid cooling and ventilating to facilitate repair or cleaning of boilers, etc.

Radiator Valve Can Be Packed Under Pressure

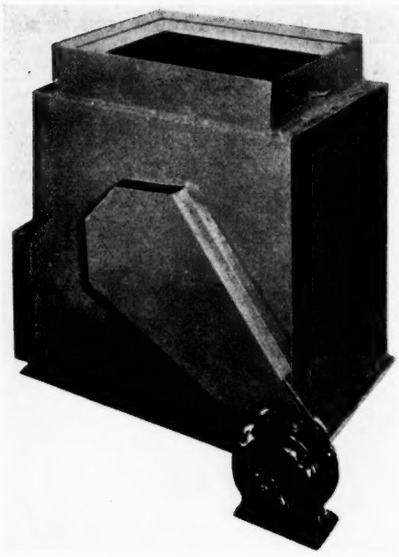
A heavy 150-lb. construction steam radiator valve that can be packed while the system is under pressure or vacuum, and which will

not jam in the open position, has been perfected by Jas. P. Marsh & Co., Chicago, Ill. The body and bonnet castings are of steam bronze and wall thicknesses throughout are much heavier than usually found in valves of this type.

The valve bonnet and disc holder are so constructed and machined that when the valve is screwed full open a tight joint is formed between the top of the disc holder and the inside surface of the valve bonnet, permitting removal of the packing nut and gland follower and repacking of the valve under pressure or vacuum without leakage. This reduces the cost and outlay of time in repacking valves. This feature also prevents any possibility of the valve jamming or sticking in the open position.

Fan-Filter Units for Warm-Air Systems

The Surface Combustion Corp., Toledo, Ohio, has announced a new series of Fan-Filter blower units, suitable for use on gas, oil, or solid-fuel-fired warm-air furnaces. The units are applicable to round or square casings and may be adapted to any specific condition. The units are designed to minimize vibration



Fan-Filter blower unit

and friction, the blower casing being insulated on the inside with sound absorbing material. The air cleaning medium is of the dry type, easily cleaned. The units are made in two sizes.

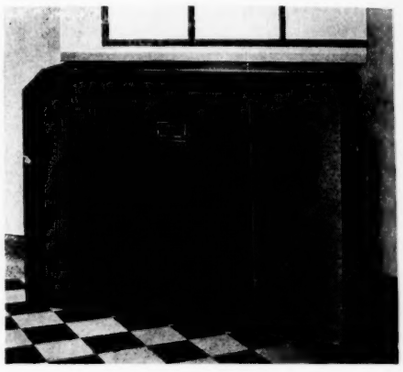
Stay-Rite Air Conditioner

Stay-Rite Co., Inc., 1250 W. Fouth St., Cleveland, Ohio, has anannounced the Stay-Rite air conditioner for better class homes. The unit is used in connection with a steam boiler, so that both steam heat and warm-air heat are available. Conditioned air is heated by a fin-type copper radiator, and the air is passed through an air mat filter. A humidifier is supplied.

The unit can be used in connection with any gas, oil or coal-fired system. The capacity is 500 sq. ft. of vapor radiation.

Trane Unit Ventilator

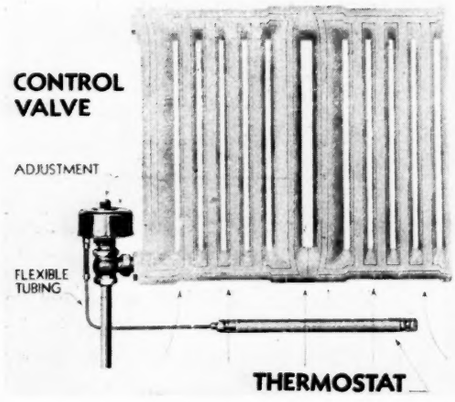
The Trane Co., La Crosse, Wis., has placed on the market a unit ventilator, the Air-o-lizer, for ventilating and heating schoolrooms, offices, public buildings, etc. The amount of steam supplied to the heater is controlled by the temperature of the air entering the unit, rather than by the temperature of the room, thus preventing cold outside air from entering the room and causing sudden drafts. The unit is available in seven standard sizes and four sizes in a recessed model.

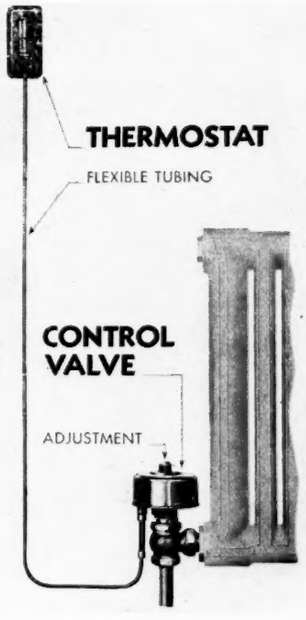


Trane unit ventilator

The fan is of the multi-blade type. The heating element is constructed of seamless copper tubing and non-ferrous fins.

The accompanying illustrations show the Powers thermostatic radiator valve, announced on these pages last month. The one to the right is controlled from a wall thermostat, the one below by a tubular-shaped thermostat for use with concealed radiators, unit heaters, and wall type radiators.





New Sizes of Cameron Motorpump

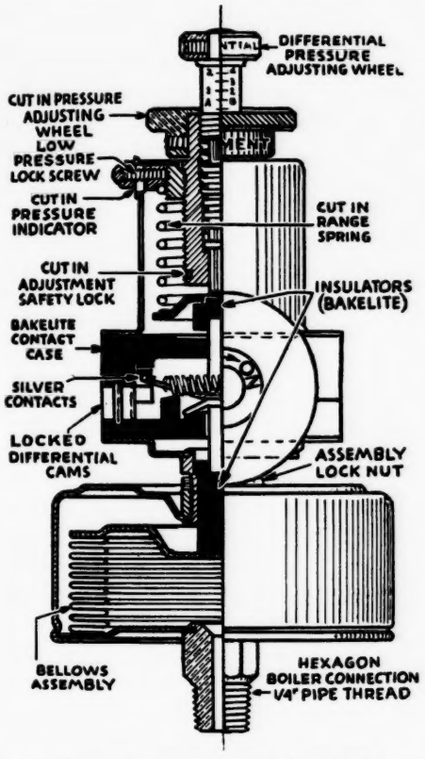
A number of new sizes have been added to the Cameron line of small general service centrifugal motorpumps manufactured by Ingersoll-Rand Co., 11 Broadway, New York. These pumps are now made in 1 in. discharge and upward. Pump and motor are assembled as a single unit with a common shaft, producing a compact, lightweight pump which requires little floor space and can be easily installed. No foundation or baseplate is needed. The discharge nozzle may be turned to any one of four positions.

There are two bearings, of the ball type, which require lubrication but once a year. There is one stuffing box, which is easily accessible. The impeller is made of bronze and is hydraulically balanced. Renewable bronze wearing rings and shaft sleeve are provided.

These pumps are used against moderate heads for a variety of services, such as in circulation systems, air conditioning equipment, stand pipe and water supply systems for factories, warehouses, apartments, swimming pools, etc.; condensate return systems; and general transfer service handling a wide variety of liquids. The pump may be obtained in various motor combinations for all ordinary current conditions and for use in hazardous locations.

B and B Controls

The Bishop and Babcock Sales Co., Cleveland, Ohio, is marketing a line of controls, two of which are illustrated. The pressure control



Steam pressure control switch

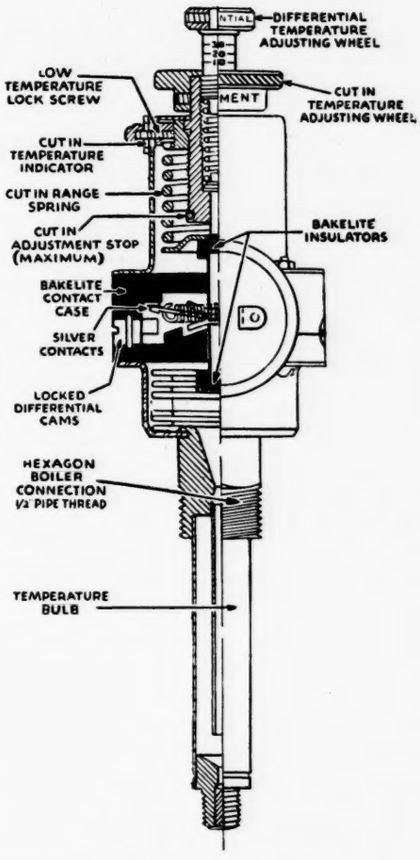
switch is made in two models, one for steam jobs and one for vapor.

The pressure control switch is so designed that the mechanism operates in a straight line. The movement is secured through the expansion and contraction of multiflex bellows, the cut in pressure being regulated by a knurled screw at the top of the control. The minimum cut out of the steam control is 1 lb., and for the vapor unit, 3 oz. Maximum cut-offs are 10 lb. and 80 oz., respectively. The differential adjustment is also located on the top of the control.

These controls can be used in connection with steam and vapor installations wherever stokers, oil burners or gas burners are used.

An immersion type control for the same purpose on hot water systems is also available, and operates on the same general principle. The range is from 140° to 170°.

The company is also selling a surface contact control with a fixed differential, designed to operate on the change in temperature of the water in the riser. The range of adjustment is approximately from 130° to 190°.



Immersion type control

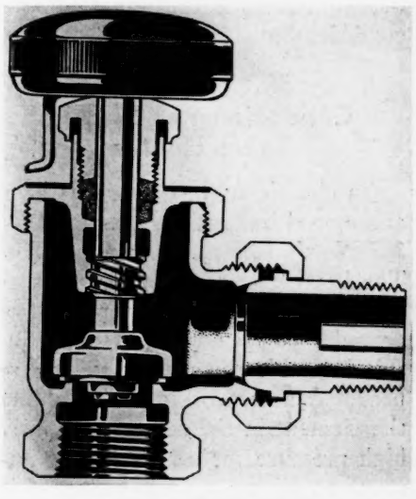
Adsco Meters

American District Steam Co., North Tonawanda, N. Y., is building the Adsco rotary condensation meter in two small sizes, one with 250 lb. capacity per hr., and the other 500 lb. per hr. The new meters are similar in design to the larger meters which have been used on district heating and industrial steam lines for many years.

The Adsco rotary is a bucket type meter, containing six identical buckets locked in position at the rotor axis. As the buckets are filled, the weight of the condensate causes rotation, discharging the buckets and bringing empty buckets successively into position for filling. The revolutions of the rotor are transmitted to the dial which registers the measurement in pounds. The meters are available in a complete range of sizes from the new 250 and 500 lb. capacities to 6000 lb. water per hr. The ease of cleaning the entire meter is one of the outstanding features.

Compak Radiator Valve

Commonwealth Brass Corp., Detroit, Mich., has placed on the market the Compak radiator valve, designed to harmonize in appearance with modern radiators and room furnishings. The bonnet is octagonal in shape, and has a stuffing box machined to receive graphited asbestos packing rings, held in place by a patented one-piece follower nut. A removable disc of composition is used.



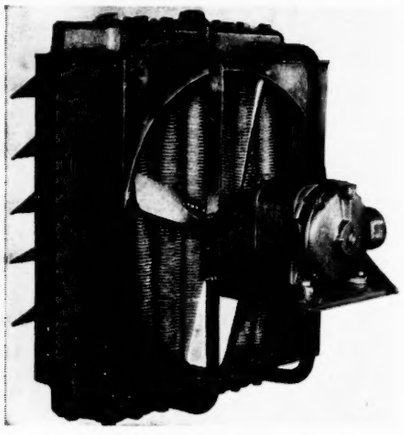
Compak radiator valve

New Equipment

The valves are obtainable in three patterns, all of the angle type, in 4 sizes from ½ in. to 1¼ in.

Grid Type RS Unit Heaters

The Unit Heater and Cooler Co., Wausau, Wis., has introduced a line of industrial unit heaters known as the Grid type RS unit heaters.



Type RS unit heater

The units are available in either cast iron or cast aluminum, 3 in. diameter heating surface with extended surface arranged two coils deep. They are made in four sizes, Nos. 10, 15, 20, and 25.

No. 10, which is an unusually small heater, has a capacity of 95 sq. ft. e.d.r. with entering air temperature of 30°, 2 lb. steam pressure and 1750 r.p.m.

The No. 25 unit has a capacity of 880 sq. ft. e.d.r. under similar conditions at 1150 r.p.m.

Cutler-Hammer Electric Space Heater

An electric space heater has been announced by Cutler-Hammer, Inc., 247 North 12 St., Milwaukee, Wis. The heating element is nickel chromium alloy. A highly refractory granular compound is used for insulation. No cement or spacers are used. A new process of imbedding the element in the compound under high pressure makes the heater immune to vibration and jarring, it is claimed. The units have a normal

Electric space heater

rated capacity of 500 watts. They are furnished for 100-125 volts and 200-250 volts, either d.c. or a.c.

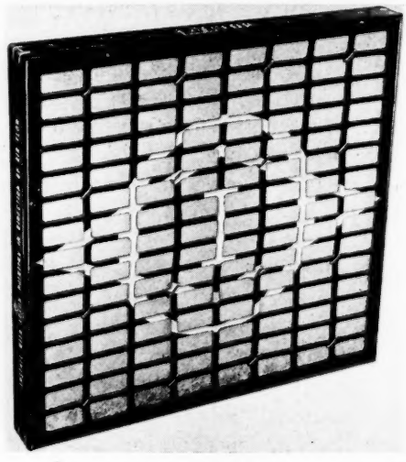
Dustop Air Filter

An air filter of glass wool, the Dustop, has been announced by the Owens-Illinois Glass Co., Toledo, Ohio.

The Dustop is a complete, self-contained air filter unit, in which the glass wool serves as the filtering medium. The unit is simple of design and so low in price as to make feasible the replacement of the complete unit when dirty. The replacement of a dirty unit is easily accomplished, no cleaning being necessary.

The container is of paper, which adds to the lightness of the unit and renders it readily disposable. While it weighs but 2 lb., it will absorb dust in excess of its own weight. The flexibility of the paper container establishes a tight seal between the filter and the metal frame into which it fits, thus preventing the passage of any unfiltered air around the unit.

With a view toward effecting further economies in the use of the device, it has been designed 2 in. in thickness, so that when a standard 4-in. pack is established by using two units in tandem, or two



Dustop air filter

units placed face to face, it is only necessary to change one-half the thickness of the total pack at one time.

Master Electric Heat Circulator

The Master Electric Co., Dayton, Ohio, has placed on the market a four-blade electric fan with an elec-

Electric fan-heater

tric heating element so placed that the air is circulated over the element and distributed throughout the room. Motors are of the brushless type, while the heater is constructed of moulded black base and motor housing with chromium plated fan blades and guard.

Link-Belt Stoker Drive

The Link-Belt variable speed stoker drive, produced by the Caldwell-Moore Plant of the Link-Belt Co., Chicago, is available as a standardized drive unit for manufacturers of underfeed screw type stokers.

The drive unit is a compact speed reducing transmission, made in various sizes for stokers ranging from 50 lb. to 1250 lb. per hr. coal feeding capacity.

The first reduction in speed is through a worm and gear set, consisting of a ground alloy steel worm and a cut bronze gear, with shafts mounted in anti-friction bearings.

Final reduction is through the medium of a 3-speed adjustable ratchet, with overload shear pin hub, and full-floating shaft.

Statistical Service

In addition to the usual monthly graphs reporting production of various items of heating and ventilating apparatus, based on Department of Commerce data, an unusually interesting chart is included (below) showing the value of building permits in 120 identical cities since 1911. The chart is published through the courtesy of *Bradstreet's*, a journal of unquestioned authority in the field of business statistics.

The charts based on the government data are, of course, a direct index of what has just taken place in the way of production, shipments and sales, and indicates fairly accurately about what we may expect is taking place today. They do not, however, guide us in determining what we might expect next week, or next year. For that reason, it is interesting to look back over the records of other years and observe what has taken place in the building industry as a whole, so that we may better understand the probable effect of past construction on future business.

The following comments are those of the staff of *Bradstreet's* on the outlook in the construction field:

"Building throughout the country goes on with utmost caution. Building-permit values in 215 cities of the United States during the month of November reached the pitiful total of a little over 57 million dollars. During November, 1930, the total was 115 million dollars and for November, 1929, the total was 166 million dollars. The decline from these two years is 49.2% and 65.3%, respectively. Building-permit values represent the total expected costs of planned building for which the municipal authorities have granted permits. Because architects' plans must be filed in advance, these values are considered about the most accurate forecast of conditions in the building industry.

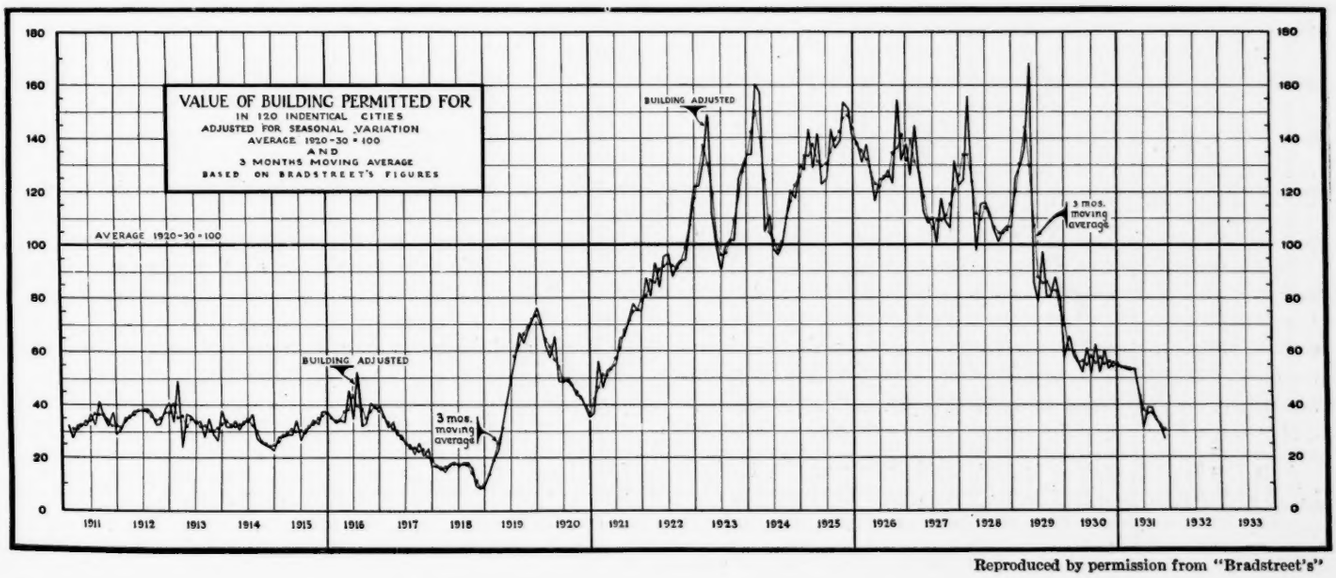
"November's total is 19 million dollars, or 25.1% less than October of this year. Ordinarily, there is a seasonal decline between the two months of 12.1%.

"It is apparent, therefore, that this drop is considerably more than we might expect normally.

"How much of this decline is due to fear of the future, or to almost certain increases in taxes that are to come and how much is due merely to lack of capital because of the depression, is hard to say. In spite of a very obvious overproduction in certain types of construction, there is undoubtedly a real need for improved homes of the single and two-family type; for schools and other public buildings, and, most especially, a great deal of improvement is needed in tenement conditions for the poor.

"Recently, the National Association of Real Estate Boards stated that the country could use, at the present time, a million and a quarter housing units, and stated further that proper housing units have not been provided for. If this is so, undoubtedly there will be a big demand for houses as soon as conditions warrant expansion. With stocks of building materials as low as they are, any sudden demand will cause prices to soar.

"It must be realized that during all this time when building is down below what appears to be normal levels, population continues to increase and old buildings continue to become obsolete. Therefore, a potential demand is being built up which eventually must be taken care of. Allen E. Beals, of the Dow Service,



Reproduced by permission from "Bradstreet's"

points this out, warning against price traps, and reports that the common brick supply around New York, as one example, is lower than it has been for some years. The Hoover housing conference was recently told that less than 5% of the single-family houses are vacant in two-thirds of the United States and in no city do the vacancies exceed 9.5%. Mr. Beals points out that this small percentage could be easily absorbed by young couples who, because of conditions and employment prospects for the future, have gone to live with their families, thereby "doubling up" on houses. These young people undoubtedly want their own homes and will buy as soon as conditions permit.

"In New York City the value of building permitted for showed a decline last month of 26.6% from October, and 56.1% from November a year ago. Four of the five boroughs contributed to this decline, with Manhattan furnishing the greatest percentage loss. In this borough the value was down 71.8% from October and 93% below November, 1930. Bronx, however, issued permits for a greater amount than either October, 1931, or November, 1930. In surrounding suburbs of New York, however, building has been going on very satisfactorily. In northern New Jersey, particularly Bergen County, because of the opening of the Washington Bridge, this year has been a particularly active one in construction. Teaneck Township has been particularly fortunate. It will show a total of new building permits granted this year of approximately 2 million dollars, of which residential building is predominant. Building material distributing companies in Long Island say that 1931 will close as the most active year since 1925 and Westchester has also seen a good year.

"In spite of the large drop for the country, as a whole, in November, 1931 has not been such a poor year for New York City. For the 11 months of this year the total value of permits issued was 343 million dollars, as against 381 million dollars in 1930, a decrease of slightly less than 10%. When it is realized that Bradstreet's Index of Building Material Prices has declined 14.1% in the past year, this is a very favorable showing. In the Central West, building permits during November were off 23% from October, and 62.8% from November, 1930, while the total for the year to date was 46% lower than a year ago.

"In Chicago, permits were issued for 442 buildings, both new construction and alterations, at an estimated cost of $1,125,000. This compares with 737 buildings at a value of $4,128,000 in November a year ago. In the Metropolitan area, exclusive of Chicago, permits were issued for 174 buildings at an estimated cost of 276,000 dollars, compared with 237 in November a year ago, valued at 868,000 dollars. The chief decline in value in this section of the country is mainly in non-residential building. In Chicago proper, however, residential and non-residential new building declined in about equal proportions, as did also permit value for alterations. Permits for new building in Chicago totalled 804,000 dollars in November.

"In the South, conditions are rather favorable. Cities in that section report an increase in building-permit values over October of nearly 14% and a decline from 1930 of only 4%. After taking into consideration the increased value of the dollar, due to declines in the prices of building materials and labor, this is an actual gain in building projects. Some of this activity is undoubtedly due to the fact that 1931 saw the peak of the normal biennial cycle in the textile industry. Its occurrence in a depression year has done much to absorb the shock of the depression in the other industries and business generally. The decline in the southern group for the 11 months of this year from the same period in 1930 is only 27.5%. In New England, also, where the textile industry is dominant, building has kept up reasonably well. Last month saw a gain in value of permitted buildings of 1.6% over October, but a loss from November a year ago of 42.9%. The comparison for the 11 months' period reveals a loss of 20.4%.

"For a long-time comparison, *Bradstreet's* has constructed an index of building-permit values which covers 120 identical cities and goes back to 1911. It is adjusted for normal seasonal variation and the 10-year period of 1920-30 average is given as 100. On this basis the index now stands at 27.3. In October, the index stood at 32.5 and in November, 1930, it was 55.6.

"Altogether, building is apparently going on very cautiously. Current figures are not very encouraging unless it is realized that, as stated, a huge need for new housing is steadily being built up with cumulative effect. It is to be hoped that when the demand occurs no such shortage will be found as in 1919 when a sudden demand caused prices and cost of labor to soar out of all reason. At present, material costs are down, labor needs employment and money is cheap. Any pickup in building will be felt in almost every industry."

Unfortunately, the manufacturers of cast iron boilers and radiators have not reported production of these commodities since August, so that we are unable to present these data this month.

Gas-fired boilers, steel boilers and oil burners each show a greater decrease for the month, as compared with the same month in the previous year, than for the first ten months of 1931, as compared with the same period for 1930, indicating that conditions are growing somewhat more unfavorable.

Air washers and air conditioning units showed the largest increase of any of the products reported, the amount being 36.6%.

The rather high amount of educational building is reflected in the orders for schoolroom unit ventilators, the orders for the month of October amounting to $275,923. The increase over the previous month being 5.2%.

Fans and blowers continue along in a rather consistent manner, the increase over the preceding month being but 2.3%.

Stokers show a decrease over the preceding month for the first time since March; the decrease, however, is not large, being but 3.3%, and the number of units being 1384 for the month of October.

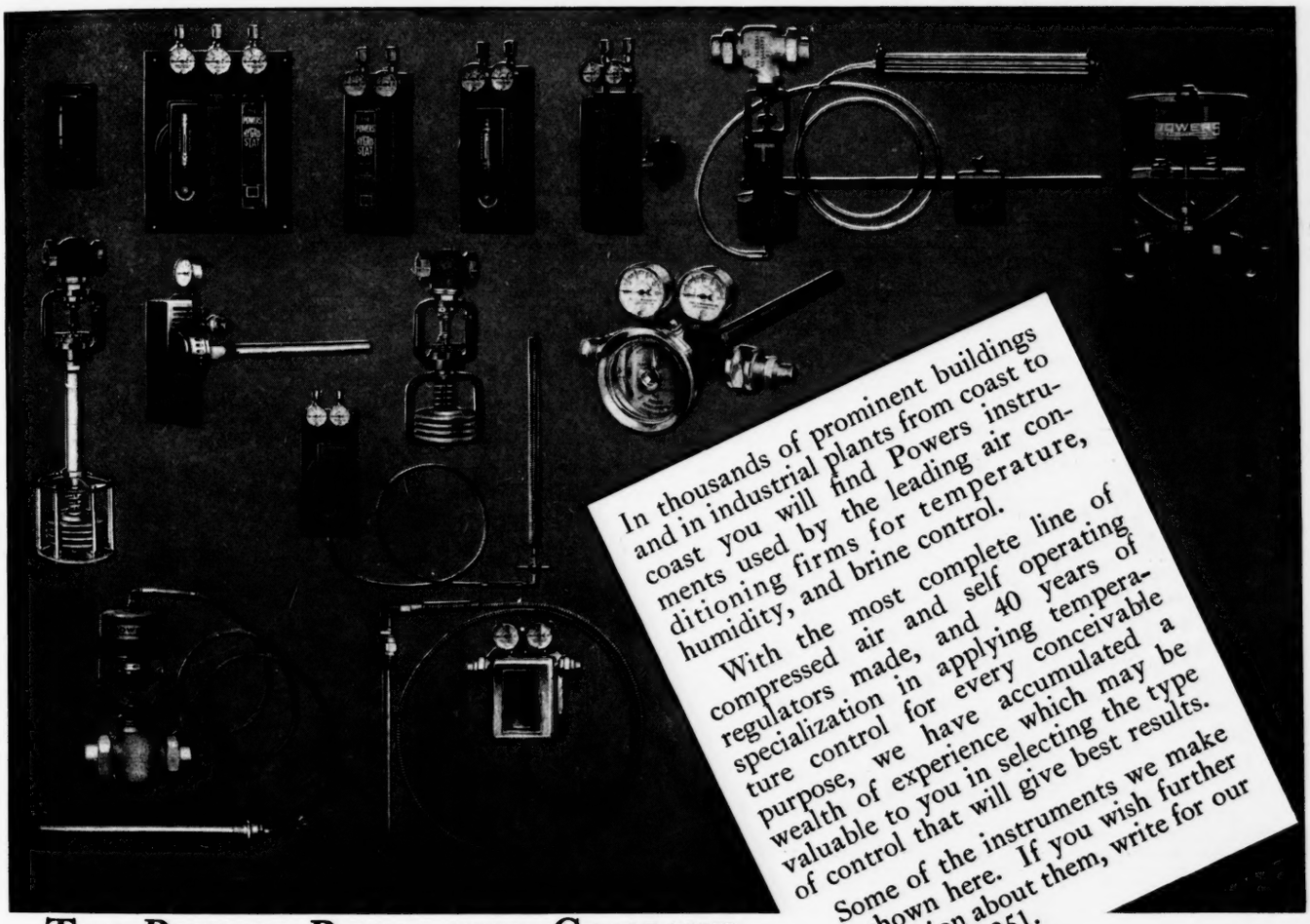
(Continued on page 80)

If

IT'S AIR CONDITIONING CONTROL *SEE*

POWERS

INSTRUMENTS for CONTROLLING AIR CONDITIONING EQUIPMENT



In thousands of prominent buildings and in industrial plants from coast to coast you will find Powers instruments used by the leading air conditioning firms for temperature, humidity, and brine control.

With the most complete line of compressed air and self operating regulators made, and 40 years of specialization in applying temperature control for every conceivable purpose, we have accumulated a wealth of experience which may be valuable to you in selecting the type of control that will give best results.

Some of the instruments we make are shown here. If you wish further information about them, write for our Bulletin No. 251.

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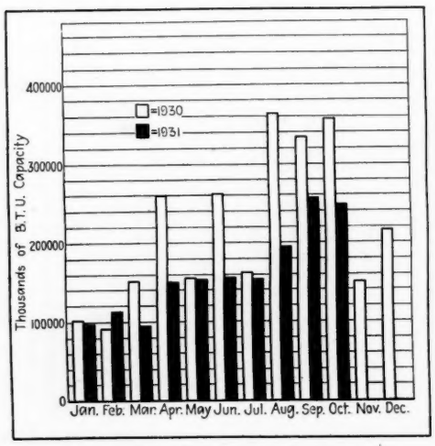
Birmingham	Chattanooga	Davenport, Ia.	Houston	Milwaukee	Pittsburgh	Salt Lake City	Montreal
Boston	Cincinnati	Denver	Indianapolis	Minneapolis	Portland, Ore.	San Francisco	Vancouver
Buffalo	Cleveland	Detroit	Kansas City	Nashville	Reading, Pa.	Seattle	Winnipeg

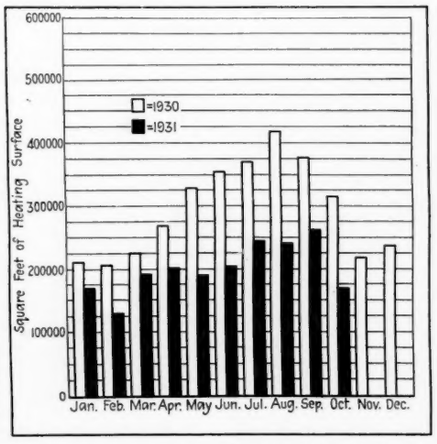
Statistical Service

(Continued from page 78)



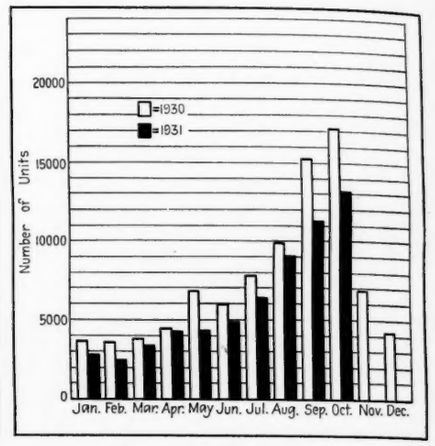
Shipments of Gas-Fired Boilers
In Thousands of B.t.u. Capacity

October, 1931, 247,732; October, 1930, 359,-206; decrease over last year, 31%; total, ten months, 1931, 1,627,743; total, ten months, 1930, 2,236,581; decrease over last year, 27.2%.



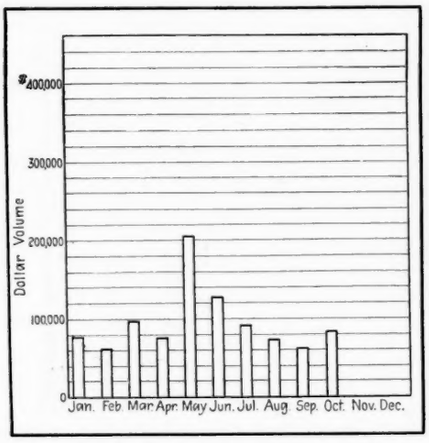
New Orders for Steel Heating Boilers
In Square Feet of Heating Surface

October, 1931, 168,950; October, 1930, 314,-240; decrease over last year, 46.3%; total, ten months, 1931, 1,992,191; total, ten months, 1930, 3,090,104; decrease over last last year, 35.5%.



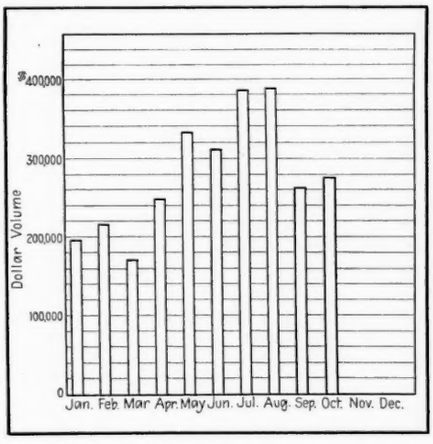
Shipments of Oil Burners
In Number of Units

October, 1931, 13,157; October, 1930, 17,124; decrease over last year, 23.2%; total, ten months, 1931, 62,179; total ten months, 1930, 77,982; decrease over last year, 20.3%.



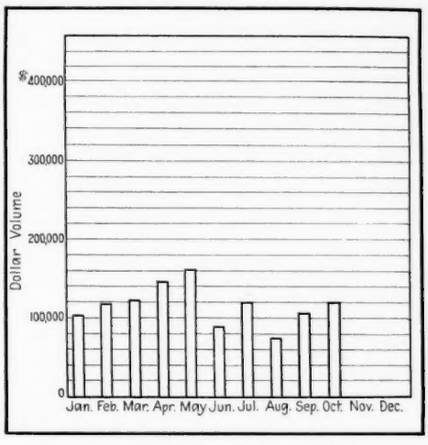
Air Washers and Air Conditioning Units
Orders in Dollars

October, 1931, $83,232; September, 1931, $60,955; increase, 36.6%.



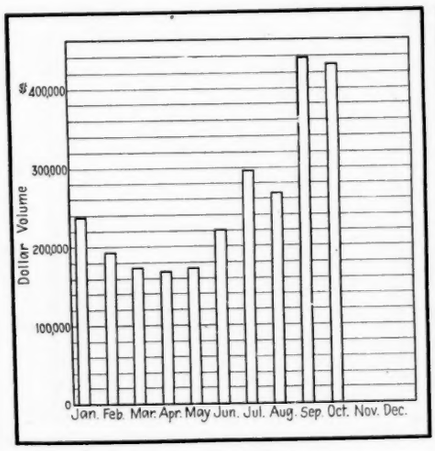
Unit Heaters (Schoolroom Type)
Orders in Dollars

October, 1931, $275,923; September, 1931, $262,274; increase, 5.2%.



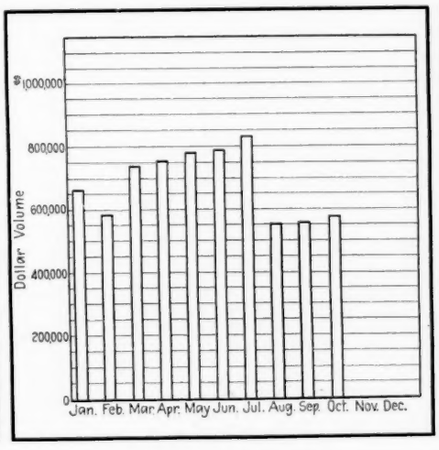
Indirect Heating Surface
Orders in Dollars

October, 1931, $120,020; September, 1931, $126,790; decrease, 5.3%.



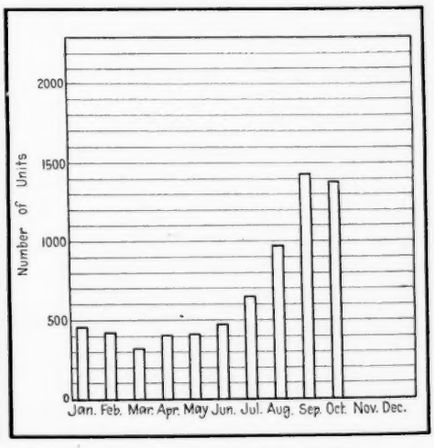
Unit Heaters (Industrial)
Orders in Dollars

October, 1931, $430,605; September, 1931, $419,410; increase, 2.7%.



Fans and Blowers
Orders in Dollars

October, 1931, $575,294; September, 1931, $562,272; increase, 2.3%.



Mechanical Heating Stokers
In Number of units installed

October, 1931, 1384; September, 1931, 1431; decrease, 3.3%.

BEAUTY *and* ENDURANCE
for these Temples of Worship

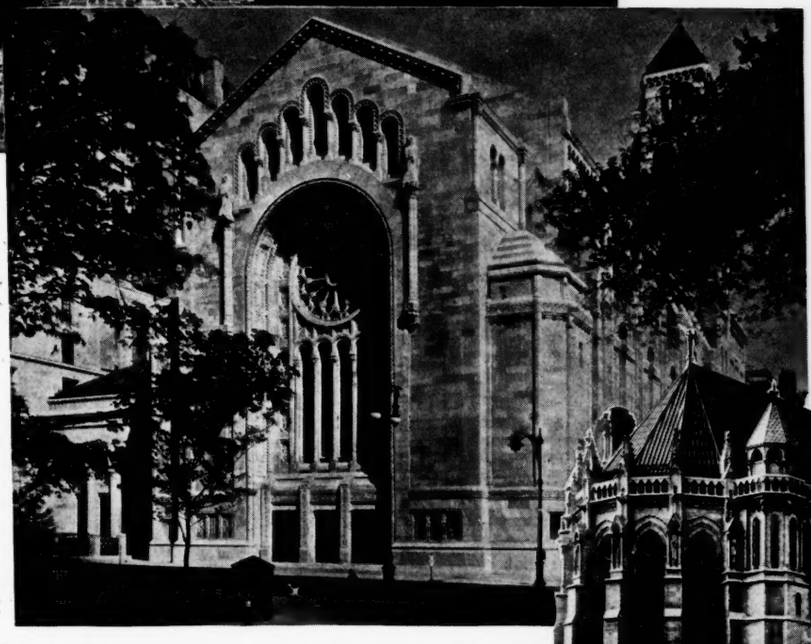
IN a religious edifice, while beauty, dignity, and appropriateness of design come first, the factor of endurance is likewise a leading consideration. Soundness and suitability for its work are not compromised in the choice of any material. The humble role of pipe, though the amount is relatively small in such a building, is of the utmost importance for *enduring* service. Therefore, NATIONAL Pipe was chosen for the heating requirements of the three splendid New York edifices here shown. Every such instance adds a little to the sanction with which NATIONAL Pipe, in various forms for various uses, is acclaimed in all parts of the country as—

America's Standard Wrought Pipe

NATIONAL TUBE COMPANY

Pittsburgh, Pa.

Subsidiary of
United States Steel Corporation



TOP—THE SEMINARY OF THE IMMACULATE CONCEPTION, Huntington, Long Island
Architect: Robert J. Reiley, New York; *Cons. Engr.:* Chauncey Matlock, New York; *Heating Contr.:* Almirall & Co., New York.

CENTER—TEMPLE EMANU-EL, New York City
Architects: Robert D. Kohn, Charles Butler and Clarence S. Stein, New York; *Heating & Vent. Engr.:* Jaros & Baum, New York; *Heating Contr.:* Alvord & Swift, New York.

BOTTOM—RIVERSIDE CHURCH, New York City
Associated Architects: Henry C. Pelton, New York City and Allen & Collens, Boston, Mass. and New York City.
Heating & Vent. Engr.: Meyer, Strong & Jones, Inc., New York.
General Contractor: Marc Eidlitz & Son, New York.
Heating Contractor: Gillis & Geoghegan, New York.

NATIONAL PIPE

With the Manufacturers

Foxboro and Division of Wilson-Maeulen Merge

The pyrometer division of Wilson-Maeulen Company, Inc., has been merged with The Foxboro Company, according to an announcement by the latter company recently.

Regulator Companies Unite

Mason Regulator Co., 1190 Adams St., Boston, Mass., recently acquired Neilan Co., Ltd., Los Angeles, Calif. The former company has long been associated in the general industrial field, while the latter company has been identified with the oil and gas industry.

Armstrong Machine Works, Three Rivers, Mich., started publication in November of The Armstrong Trap Magazine, a monthly house organ, to be devoted to the latest developments and practice in the steam trap field. Copies of the magazine may be obtained free from the company.

Uni-Flo Grille Products Co., Detroit, Mich., recently moved to 2265 W. Grand Avenue.

The Maxim Silencer Co., Hartford, Conn., has established, as an addition to its regular business, a consulting service which will specialize in the solution of noise problems. It is headed by Dr. Hiram Percy Maxim, inventor of the Maxim Silencer, and will have at its disposal the services of the entire engineering and research staffs of the company.

Capitol Brass Division of the Bohn Aluminum & Brass Corp., Detroit, Mich., has acquired all manufacturing and selling rights of the Conco temperature control valve.

Gas & Electric Heater Co., Utilities Division of Bastian-Morley Co., La Porte, Ind., has appointed H. P. Halvorsen as New England representative.

Pierce, Butler & Pierce Mfg. Corp., 41 East 42nd St., New York, N. Y., announces the following: Philip J. Faherty, vice-president, has been appointed Director of Sales, succeeding Martin A. Rooney; Walter C. Moriarty is now district manager of the Worcester and Boston branches; and Fred Good, previously in charge of the Akron branch, is now district manager of the Ohio territory.

Farnsworth Company has moved to Watertown, N. Y. from Conshohocken, Pa. In the future all its equipment will be manufactured by The Bagley and Sewall Company, both companies now having offices in the same building.

Autovent Fan & Blower Co., 1805 N. Kostner Ave., Chicago, is distributing a 21-page loose leaf catalog on its line of unit heaters.

Experienced Engineers Available

1. Eight years' experience in southern territory handling heating specialties. Good acquaintance among contractors and jobbers.
2. Estimator and engineer of wide experience in all branches of heating and piping industry. Capable making layouts, superintending and erecting installations.
3. Engineer and draftsman for heating, ventilating or structural design and layout. College degree. Five years' experience with consulting firm.
4. Engineer with well rounded experience in heating, ventilating, air conditioning, refrigeration and piping in responsible charge of work in office and on the job.
5. Sales engineer with wide experience in steel boiler field and large acquaintance in East. Also familiar with all other lines of power plant equipment.
6. Engineer capable of designing heating and ventilating systems, calculating radiation and pipe sizing and steam requirements. Also has knowledge of plumbing.
7. Sales engineer with extensive experience in warm air heating field as well as fan business, including supervision of installations.
8. Mechanical engineer with college degree. Has experience in drafting, estimating and sales.
9. Estimator and engineer able to make layouts for all types of mechanical equipment of buildings.
10. Sales engineer familiar with eastern and middle west territories. Has had ten years' experience selling heating, ventilating and air conditioning equipment.
11. Heating, ventilating and sanitary engineer desires position as estimator, construction superintendent or purchasing agent in heating, ventilating and plumbing field.
12. Engineer with ten years' experience handling heating, air conditioning, plumbing, refrigeration and electrical work. College degree.
13. Sales engineer capable of designing heating and ventilating systems. Splendid experience.
14. Estimating, designing and sales engineer with wide experience on all types of construction, such as office buildings, department stores, theatres, restaurants, banks, etc., and well acquainted in Middle West. Five years' experience with well known firm manufacturing heating specialties—also over a year's experience with prominent consulting engineer.
15. Sales engineer with experience in East with well known engineering firms.
16. Heating and ventilating engineer with extensive experience in the Middle West in designing, layout and field supervision of central station systems, ventilating and air conditioning, plumbing and piping. B. S. degree.
17. Air conditioning engineer with college degree.
18. Engineer qualified for research and design work in heating, ventilating and air conditioning field. Has also had considerable experience as sales engineer.
19. Engineer with experience as designer and engineer in charge of heating, ventilating, air conditioning and processing equipment.
20. Draftsman and engineer qualified to design heating and ventilating and air conditioning systems.

For further information address all inquiries to

EMPLOYMENT SERVICE

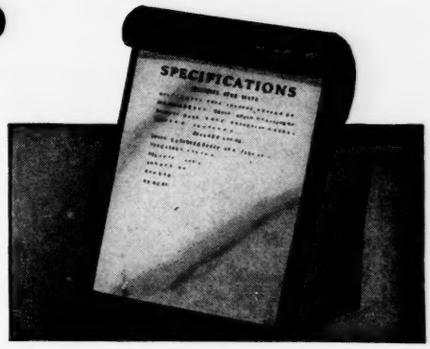
AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

51 Madison Avenue, New York, N. Y.

Specifications

that really specify

state combined air and water capacity of the heating pump

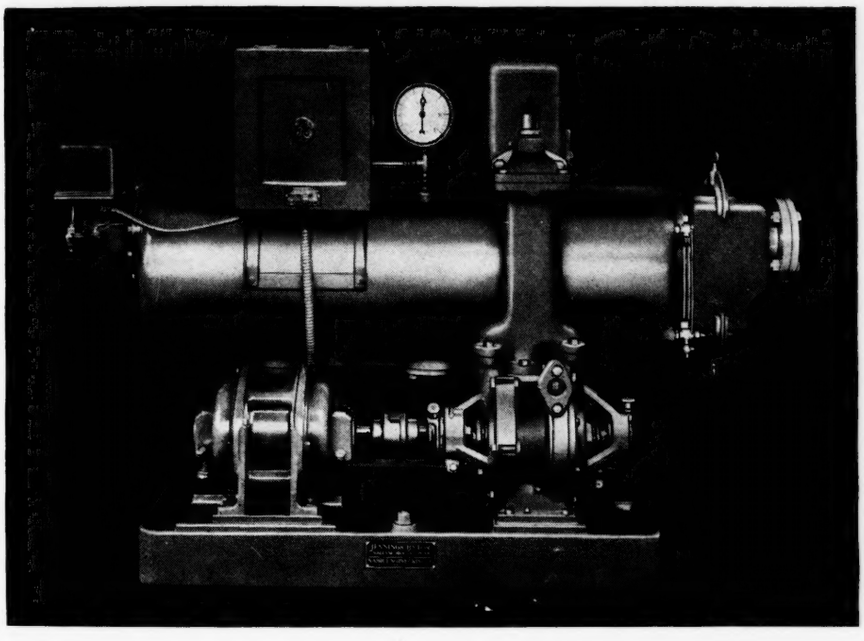


A VACUUM heating pump may have ample air capacity to maintain the desired vacuum on a given amount of radiation. Or, its water capacity may be adequate to keep the system clear of condensation. But, unless a pump can deliver its full rated volumes of air and water *at the same time,* dependable and economical operation cannot be assured.

All guess-work about this important factor can be eliminated by specifying combined air and water capacity.

If the pump is a Jennings, you can be positive that it will meet your specifications. Consisting of two independent pumping units, the Jennings Vacuum Heating Pump handles air and water separately. Air capacity is not affected by the volume of water being pumped. Water capacity remains constant when air is being handled. Combined air and water capacity is maximum air capacity plus maximum water capacity.

Available in no other heating pump, the extra capacity provided guarantees satisfactory performance under all conditions. Peak loads are readily handled. Power consumption is small. Operating costs are low.



Jennings Vacuum Heating Pumps are furnished in capacities of 4 to 400 g.p.m. of water and 3 to 171 cu. ft. per min. of air. For serving up to 300,000 sq. ft. equivalent direct radiation. Write for Bulletin 85.

VACUUM PUMPS AND COMPRESSORS FOR AIR AND GAS • • RETURN LINE AND AIR LINE VACUUM STEAM HEATING PUMPS • • CONDENSATION PUMPS CENTRIFUGAL PUMPS • • SUCTION (SELF-PRIMING) CENTRIFUGAL PUMPS • • BILGE PUMPS • • SEWAGE PUMPS • • PNEUMATIC SEWAGE EJECTORS

NASH ENGINEERING COMPANY, 81 WILSON ROAD, SOUTH NORWALK, CONN.

Jennings Pumps

Degree Days and Unit Fuel Consumption in Typical Cities

November, 1931

UNIT fuel consumption figures given below must be corrected for efficiency, heat content of fuel other than that listed below, for radiation emitting other than 240 B.t.u. per hr., and for radiation calculated on a basis other than zero outside to 70° inside.

Coal is assumed as having a heat content of 12,000 B.t.u. per lb., gas, 1000 B.t.u. per cu. ft., and oil, 140,000 B.t.u. per gal. To correct for other heating values, multiply the fuel consumption listed under the charts by the standard heat content just listed, and divide by the heat content of the fuel actually being used in the installation being calculated.

For radiation installed for any other outside temperature than zero, multiply the fuel consumption given under the charts by 70°, divided by the quantity (70 minus the outside temperature used).

To correct for efficiency, divide the fuel consumption by the efficiency of the heating installation.

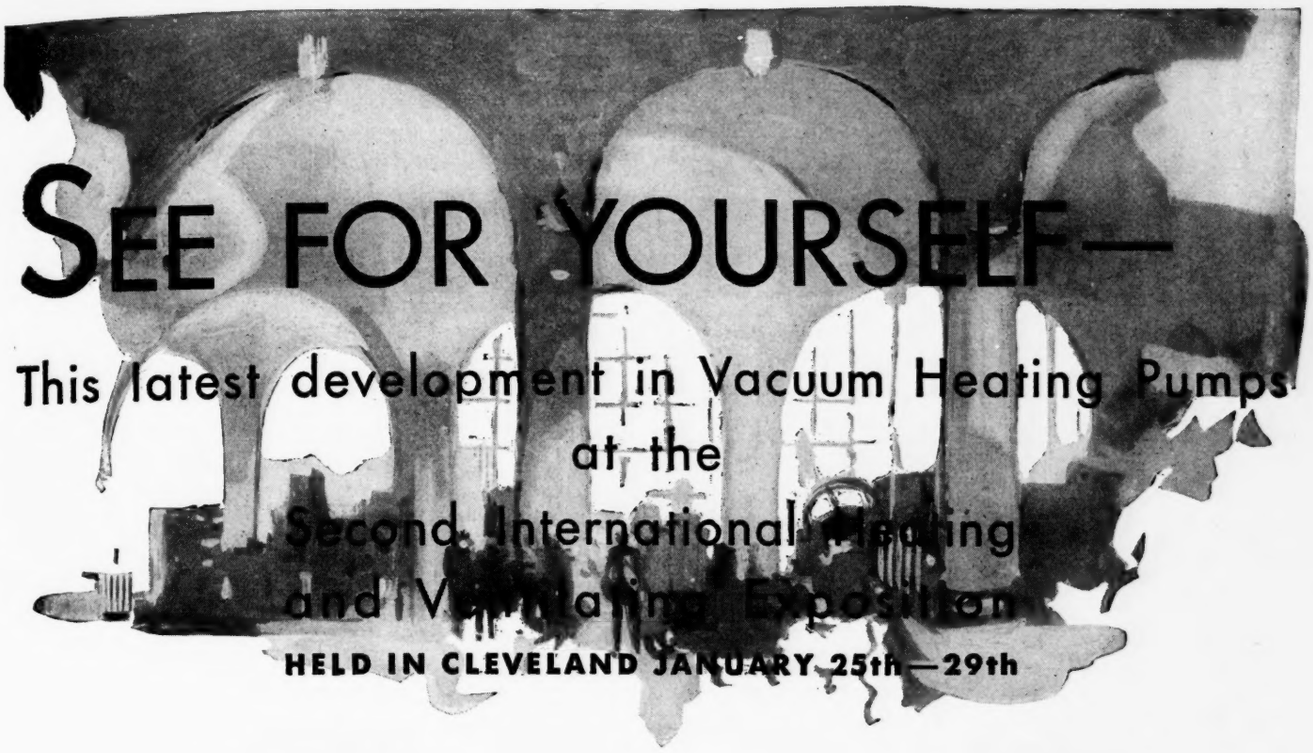
For water radiation, multiply the fuel consumption which is given for steam radiation by 5/8.

	New York	Seattle	San Francisco	Chicago	Denver	Boston	St. Louis	Pittsburgh	Minneapolis
Degree days	404	658	516	452	823	470	322	409	742
Total degree days since September 1	606	1208	791	718	1217	761	506	725	1140
Lb. of coal per sq. ft. of radiation for November	3.232	5.264	4.128	3.616	6.584	3.760	2.576	3.272	5.936
Gal. of oil per sq. ft. of radiation for November	0.277	0.451	0.354	0.310	0.564	0.322	0.221	0.280	0.508
Cu. ft. of gas per sq. ft. of radiation for November	38.78	63.17	49.54	43.39	79.01	45.12	30.91	39.26	71.23

	Los Angeles	Baltimore	Philadelphia	New Orleans	Atlanta	Cleveland	Cincinnati	Detroit
Degree days	214	314	334	26	176	418	356	515
Total degree days since September 1	241	448	480	34	270	700	605	830
Lb. of coal per sq. ft. of radiation for November	1.712	2.512	2.672	0.208	1.408	3.344	2.848	4.120
Gal. of oil per sq. ft. of radiation for November	0.147	0.215	0.229	0.018	0.121	0.287	0.244	0.353
Cu. ft. of gas per sq. ft. of radiation for November	20.54	30.14	32.06	2.50	16.90	40.13	34.18	49.44

	Buffalo	Birmingham	Indianapolis	Memphis	Des Moines	Kansas City	Louisville	Galveston
Degree days	513	127	394	226	598	437	309	44
Total degree days since September 1	875	186	642	305	883	609	483	48
Lb. of coal per sq. ft. of radiation for November	4.104	1.016	3.152	1 808	4.784	3.496	2.472	0.352
Gal. of oil per sq. ft. of radiation for November	0.352	0.087	0.270	0.155	0.410	0.300	0.212	0.030
Cu. ft. of gas per sq. ft. of radiation for November	49.25	12.19	37.82	21.70	57.41	41.95	29.66	4.22

Fuel consumption figures must be corrected for local conditions as explained above.



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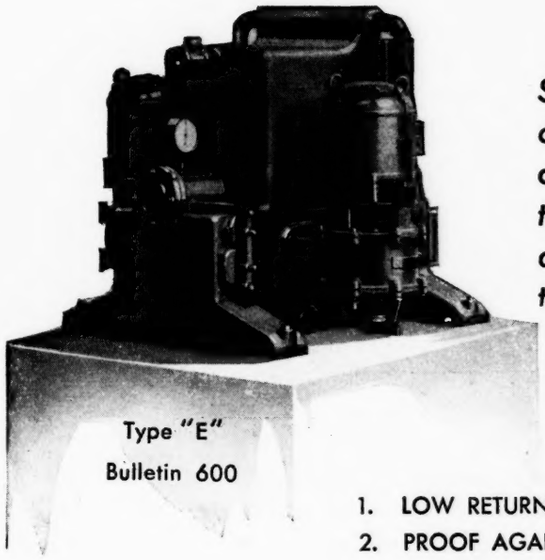
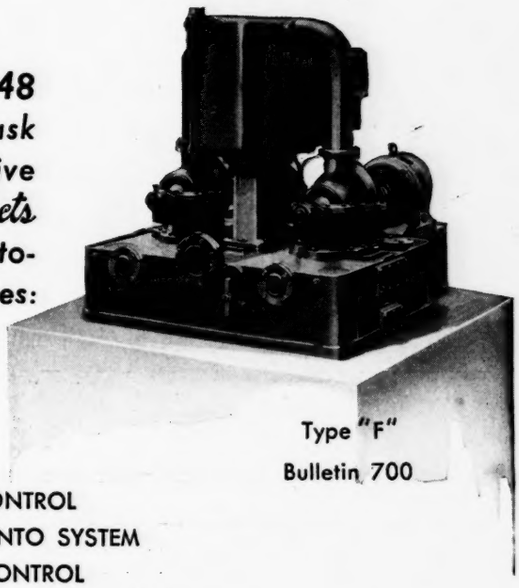
This latest development in Vacuum Heating Pumps at the Second International Heating and Ventilating Exposition

HELD IN CLEVELAND JANUARY 25th—29th



Type "E"
Bulletin 600

Stop at Booths **448** *and* **450** *and ask our representative to tell you the facts about these up-to-the-minute features:*



Type "F"
Bulletin 700

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2. PROOF AGAINST AIR LEAKAGE INTO SYSTEM
3. DOUBLE VACUUM REGULATOR CONTROL
4. BALANCED VIBRATIONLESS OPERATION
5. ELIMINATION OF PUMP AND MOTOR MISALIGNMENT
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7. REDUCED FLOODING HAZARD OF MOTORS
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